THE ENDOGENEITY OF MONETARY POLICY IN AUSTRALIA 1961-1974

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ABSTRACT

The aim of this thesis is to analyse the setting of the individual monetary policy instruments by the Australian monetary authorities over the period 1961-1974. The motivation for the analysis of such an issue stems from the increasing interest in monetary economics and the growing sophistication of the Australian capital market. The rapid increase in the money stock from 1973 onward has emphasized the need for more direct controls on the growth of the money supply. Successful control depends on a working knowledge of the behaviour of the instruments required.

The analysis of the setting of individual policy instruments is pursued in order to determine whether the monetary authorities set the instruments endogenously and in response to movements in policy targets, or whether they set the instruments independently. If the instrument setting is found to be endogenous, several related issues arise: the possible assignment of the instruments, the interdependence between the instruments and the temporal stability of the policy responses.

Before attempting to accomplish this aim, two chapters are devoted to a review of monetary-fiscal literature and previous reaction function estimation. These chapters serve as a background to the problem at hand. The monetary-fiscal debate brings to light two related issues - reverse causation and the identification problem. The reverse causation argument concerns the issue of whether the money stock is the cause or effect of economic activity. If it is the cause, then the money supply can be treated as exogenous. Alternatively, if it is the effect, then the money supply should be treated endogenously. The identification problem relates to the issue of how the variables are defined and identified. The success of the empirical tests in the monetary-fiscal debate depends upon this issue. The review of the previous reaction function studies provides an insight into the identification problem. Each of these studies has

attempted to define the variables in the most suitable way. Although none of these earlier formulations are exactly suited to the present problem, they serve to provide valuable background.

In Chapter 4, a simple model of money supply determination is used to identify the appropriate monetary instruments for the Australian economy. The reaction functions are then formulated and the problems of data and estimation are discussed. The regression results are discussed in Chapter 5. Results are also presented for the time period split into the contractionary and expansionary phases of economic policy. The differing response of the instruments to each policy target is observed. This test is an important aspect of the more general problem of temporal stability of the reaction functions. The problem is examined by applying the TIMVAR technique and identifying the various periods of instability.

Much of the observed instability is obviously due to the changing weights on the targets during different phases of monetary policy. The SRD function is analysed in terms of the movement in Australia's economic cycle. It is observed that there is a close connection between the periods of instability in the function and movements in the cycle. A similar analysis is carried out for the securities function, this time in terms of the movement in the level of foreign reserves. In this case, however, the connection is no as obvious or specific. The results of this analysis are presented in Chapter 6.

In Chapter 7, the policy implications of the analysis are discussed. It is felt that more work in this area is warranted, especially in regard to the determination of response lags.

CHAPTER 1 - INTRODUCTION

The object of this thesis is to analyse the setting of the individual monetary policy instruments by the Australian monetary authorities over the period 1961-1974. The pursuit of this objective involves an examination of several problems. The first focuses on the central issue of the authorities' philosophy towards monetary policy: either they set the instruments endogenously and in response to movements in the policy targets, or they set the instruments independently. If the instrument setting is endogenous, then a number of related issues arise. The first is found in a comparison of the response of the individual instruments. A differing response in each case may indicate that the authorities have assigned the instruments to deal with specific economic problems. A second related problem concerns the potential interdependencies that may exist between the instruments themselves. A leading example is the nature of the relationship between interest rates and the success of open market operations. A final issue is the temporal stability of the policy responses.

The motivation for an approach to these problems stems from the resurgence of interest in monetary economics and the growing sophistication of the Australian capital market. The emphasis in Australian monetary policy to date is centred on the role of administered interest rates with the other monetary aggregates, such as the cash base of the economy or the money supply, varying freely. However, the consequences of a rapid growth in the money stock became apparent from 1973 onward. The events of this period underline the need for more direct controls on the growth of the money stock. The efficacy of such controls depends on a working knowledge of the behaviour of the instruments required to control the money supply. This thesis attempts some preliminary work in this direction.

1.1 Methodology

The genesis of this thesis is contained in a detailed review of the monetary literature. This review is presented in two related parts. The first focuses on the relevant aspects of the monetary-fiscal debate which brings to light two fundamental issues: *reverse causation* and the *identification* problem. The reverse causation argument centres on the issue of whether the money stock is the *cause* or *effect* of economic activity. If it is the cause, then changes in the supply of money influence the level of economic activity. The alternative view is that changes in the money stock are engendered by changes in the level of activity. In brief, the former view treats the money supply as an exogenous variable whereas the latter treats it endogenously. Much of the criticism contained in the monetarist-fiscal debate concerns the definition of the key aggregates. There is clearly an important identification problem. The success of the empirical tests, which support one or other of the views, depends upon the way in which the variables are defined and identified. Thus the first step in this dissertation is to draw out the relevant issues in the monetary-fiscal debate on these two basic issues.

Given the importance of the endogeneity problem and reverse causation, it is necessary to review the literature relating to these problems. Endogeneity of the instruments of monetary policy is accommodated in economic models by formulating a separate reaction function for each instrument. These functions explain the instrument setting in terms of the targets of economic policy. The incorporation of reaction functions in structural models of an economy clearly affect the size of the dynamic policy multipliers. The review of previous reaction function studies provides insights into the identification problem mentioned earlier. Each study has attempted to define the variables in the most suitable way. Clearly, none of the earlier formulations are suited exactly to the present problem, although they provide valuable background.

The identification problem is resumed when appropriate reaction functions are formulated for the Australian monetary policy instruments. Here, three policy instruments are defined: the SRD ratio, the Reserve Bank's holdings of Government securities (S) and 'the' interest rate. The first two are treated endogenously and reaction functions are formulated for them. Reasons are advanced for treating the interest rate as an exogenous variable in the equations for SRD and S. These two reaction functions embody three short term policy targets: the rate of inflation ($\dot{P}$), the rate of unemployment (U) and an external target (FR). In addition, the equations are formulated to accommodate interdependencies between S and SRD.

These equations are fitted to quarterly data for the period 1961(1) - 1974(4) and the results reported. The reaction of the two instruments is examined according to the authorities' policy intention. The time series is split into phases when the policy intention is either contractionary or expansionary. This test is an important aspect of the more general problem of temporal stability of the reaction functions which is examined by applying the TIMVAR technique and identifying periods of instability. The thesis concludes with a summary of the policy implications of these reaction function studies.

1.2 Scope

The study is confined to the time series 1961(1) - 1974(4). Quarterly data is used throughout the analysis in preference to both monthly or annual data. Monthly data is not available for all the variables used in the analysis. Quarterly data is more appropriate for the current study than annual data because the test concerns the short term reaction of monetary instruments to targets. There may be a current period reaction within the month but this is ignored because of the lack or unreliability of monthly data. The study focuses on the within quarter reaction.

The thesis concentrates on an evaluation of monetary policy reaction. Government expenditure functions are estimated but prove to be relatively insignificant. Government expenditure is found to respond primarily to growth. Also, the quarterly time period is obviously too short for this fiscal instrument, which is more realistically seen as a longer-run policy variable. Within the context of a quarterly model, therefore, it appears more appropriate to assume that government expenditure is exogenous. The instruments of fiscal policy are more likely to be endogenous within the context of a model fitted to annual data.

The estimates of the two reaction equations are based on ordinary-least-squares adjusted for serial correlation. This correlation is introduced by distortions in the data input. For example, data relating to internal, inter-governmental transactions in government securities were not available and could not be eliminated from the series on the variable S. The estimates of the functions subsume a fixed exchange rate regime which prevailed in the Australian economy over the time series considered.

1.3 Outline of thesis

Chapter 2 contains the first part of the review of the literature. This draws out the relevant aspects of the monetarist-fiscal debate. In particular, the two issues of reverse causation and the identification problem are emphasized. The second aspect of the review of the literature is contained in the third chapter. There, the problem of endogeneity is discussed in general terms and the various reaction function studies, evoked by this issue, are analysed.

Reaction functions for Australia are specified in Chapter 4. Two equations are formulated, one for the SRD ratio and the other for the Reserve Bank's holdings of Government securities. These instruments are preferred to the cash base or the money supply since they both have their impact on the money supply in different ways. This point is illustrated by reference to a simple model of money supply determination. Chapter 5 presents the results of the reaction function estimation. Examination is also made, in this chapter, of the effect of splitting the sample period in contractionary and expansionary phases. Chapter 6 tests the general stability of the estimated functions using the TIMVAR technique. The policy implications of the estimated functions are set out in Chapter 7.

CHAPTER 2: TWO APPROACHES TO THE STUDY OF THE IMPACT OF MONEY AND MONETARY POLICY

The monetarist-fiscal policy debate has proceeded unabated for a number of years. The extremities in the debate are concerned with the relative effectiveness of monetary policy action in influencing the economic aggregates. At one extreme are some Keynesian economists who argue that 'money does not matter at all'. At the other extreme are those monetarists who sponsor the view that 'money matters most'. The resolution of the controversy depends upon a detailed empirical evaluation of the issues involved, and although the monetarists would claim that past empirical work strongly supports their position, the results are far from conclusive.

This present chapter concentrates on a review of the 'monetarist' approach and, in particular, recognizes that such an approach has proceeded along two lines; the direct estimation and the structural model approach. Both will be reviewed in this chapter. The major emphasis in this chapter is on monetary policy, which is the subject matter of this thesis. Monetary and fiscal policy however, are closely linked, and we cannot avoid comparisons of their relative impact and effectiveness.

Several important points are necessary before a review of the 'monetarist' approach can be undertaken. The points relate basically to the inaccuracy of postulating a strict 'Keynesian' approach in which money is held to be unimportant. In fact, the two protagonists in the 'monetary-fiscal' debate are *not* directly opposed with respect to their views on the importance of money in determining the level of economic activity. Whereas the extreme 'monetarist' view that 'money matters most' is taken to preclude the influence or importance of fiscal policy, the opposite argument does not hold. Keynesian theory has always recognized the importance of both monetary and fiscal policy on economic aggregates. Leijonhufud's [33] re-appraisal of the Keynesian revolution is one major attempt to draw the important distinction between *Keynesian economics* and *the economics of Keynes*. In doing so, the author assigns a far more important role to Keynesian monetary policy, especially in the maintenance of full employment.

The genesis of the 'monetary-fiscal' debate occurred with the publication of the study by Friedman and Meiselman [20] (hereafter referred to as F-M) in which the authors sought to compare a quantity theory model and an autonomous expenditure ('Keynesian') model of induced changes in the economy. This study represents the starting point for the so-called 'direct estimation' approach to the monetary-fiscal debate. The F-M study is subject to considerable criticism and in the aftermath Andersen and Jordan [6] (hereafter referred to as A-J) attempt to modify and extend the F-M results. This study also is reviewed in detail.

These single-equation studies are then compared with studies by Kmenta and Smith [28] and Moroney and Mason [40] who evaluate the relative effectiveness of monetary and fiscal policy with the aid of a small structural model, in preference to a single equation system. The analysis of these studies focuses on their treatment of the monetary policy variables. A similar analysis is conducted with respect to an Australian study by Zerby [47] which can be interpreted as an attempt to compare the relative impact of monetary and fiscal policy despite the fact that the author emphasizes his preference for experimenting with monetary policy. Two important observations are made on the alternative approaches to the study of the monetary-fiscal debate: firstly, neither the direct estimation *nor* the structural equation models accommodate the potential endogeneity of the policy instruments; secondly, they both fail to adequately define the instruments of monetary policy. These two associated problems serve to provide an introduction to the so-called 'reaction function' studies and the general problem of endogeneity, both of which are discussed in Chapter 3.

2.1 The Friedman-Meiselman study

The first major development in the exposition of the monetarist view comes with the publication of the study by Friedman and Meiselman. This study seeks to compare a simple quantity theory model with a simple autonomous expenditure theory model. F-M maintain that the important argument in the debate is not theoretical but empirical. In terms of this empirical approach, the two theories compared by F-M conflict as to which of the two relationships is:

(i) critical in the sense of being the primary source of change or disturbance in economic activity;

(ii) stable, in the sense of being able to express, empirically, a consistant relationship.

The authors choose a simple level of study because they believe that the decisive issue is extremely basic in nature. To this end, they set out the two alternative theories as follows:

$$Y = a + V'M \tag{2.1}$$

$$Y = \alpha + K'A \tag{2.2}$$

where Y = nominal community income

M = stock of money

V' = income velocity

A = autonomous expenditure

K' = marginal autonomous expenditure multiplier.

The criteria for choosing the periods of time to be studied are firstly, that the comparisons be made for relatively short periods of time, and secondly, since the relationships might differ at different phases of the economic cycle, it is necessary to ensure that one comparison covers one or more complete cycles. This will avoid any source of distortion from cyclical variations. The authors select the period 1897-1959. Annual observations are used for the entire period, but quarterly observations are introduced from 1945 onwards. The time period is broken into thirteen sets of subperiods for which annual data is used, and one or two subperiods for which quarterly data is used. These various subperiods are as follows:

Annually	Quarterly
1897 - 1958	1945(3) - 1958(4)
1897 - 1908	1946(1) - 1959(4)
1903 - 1913	
1908 - 1921	
1913 - 1920	
1920 - 1929	
1921 - 1933	
1929 - 1939	
1933 - 1938	
1938 - 1953	
1939 - 1948	
1948 - 1957	
1929 - 1958	

F-M also encounter a statistical problem brought about by the correlation between the variables on the two sides of the equation (2.2). Since, by definition,

$$Y = C + A \tag{2.3}$$

then observations of Y and A for the same period would entail correlation of Y with some part of itself. Thus, the authors argue that it is preferable, in the absence of lagged responses, to use

$$C = \alpha + KA \tag{2.4}$$

where C = induced consumption expenditure

and K = K' - 1.

Equation (2.1) is correspondingly altered to

$$C = a + VM \tag{2.5}$$

The authors also combine (2.4) and (2.5) to obtain

$$C = \alpha + KA + VM \tag{2.6}$$

This particular formulation is estimated in order to determine whether the correlation between C and M is significantly different from the correlation between M and A. The partial correlations of M and A indicate the net contribution of each to the explanation of C, keeping the other constant.

Price indices are also added as an additional independent variable, resulting in the following equations:

$$C = a + VM + BP \tag{2.7}$$

$$C = \alpha + KA + BP \tag{2.8}$$

$$C = \alpha + VM + KA + BP \tag{2.9}$$

One important implication of using these real variables is pointed out by the authors. They suggest that when nominal magnitudes are used, it is plausible to suggest that the direction of causation would run from the stock of money to the dependent variable (C or Y). In the case of real variables, however, the direction of causation is not as clear cut, since the money stock (real) is not under the control of the monetary authority as is the nominal value of the money stock. This is because the public determine the real stock of money by bidding prices either up or down.

Apart from the basic criticisms of the F-M approach (see 2.1.1 below), Stephanie Edge [19] suggests that the form of the equations used by the authors is not well founded theoretically. She suggests that, out of the six equations tested, only two [(2.8) and (2.6)] can be legitimately derived from theoretical models. Rao [43], in a mathematical exposition of the problem, attempts to show that such a criticism cannot be substantiated, and that the six equations tested can be grouped according to whether or not they assume the existence of 'money illusion'.

In attempting to define the variables to be used, F-M find that there is no clear-cut agreement on the statistical definitions of 'autonomous' and 'induced' expenditure, and no criteria for choosing particular definitions. This aspect of the monetary debate forms the subject of numerous articles which followed publication of the F-M study. Its importance is critical however, since many analysts suggest quite correctly, that the F-M findings stand or fall on the accuracy, or otherwise, of their definitions.[1]

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1. The definitions eventually decided on were:

   M = currency in public circulation + adjusted demand deposits + time deposits in commercial banks

   A = net private domestic investment + government deficit on income and product account + net foreign balance

   P = consumer price index.

Describing the results of their findings as 'remarkably consistent and unambiguous' and the evidence obtained as 'one-sided', F-M find that, for the 62 years as a whole, and for all but one of the 12 overlapping periods, and for both annual and quarterly data (after 1946), the stock of money is more highly correlated with C than is the level of autonomous expenditures. The only exception to this result is the period 1929-39 in which autonomous expenditures are found to have more influence on consumption than the money stock. Table 2.I below tabulates the results of estimating equation 2.6.

Tables 2.II and 2.III below tabulate the regression equations 2.4 and 2.5 for the various overlapping periods, as well as the quarterly regression from 1945 - 1958.

The results obtained also support the view that a positive correlation between C and one of the other variables might simply reflect the influence of this other variable in disguise. The partial correlations show that except for the period 1929-39 the relation between A and C is simply a disguised reflection of the effect of M. The positive correlation between M and A produces a simple positive correlation between A and C. The authors find that, when M is held constant, the partial correlation between A and C is small and often negative. However, the partial correlation between M and C is almost as strong as the simple correlation coefficient except for the period 1929-39. See Table 2.IV below.

The introduction of the price variable in the equations emphasises the 'one-sided' nature of the results. For every period except 1938-53, $r_{CM.P} > r_{CA.P}$, and, in this particular period, both correlations are negative. The second order partial correlations, shown

TABLE 2.I

Relations in Nominal Terms: Multiple or Simple Regression Equations Between Consumption or Income and Synchronous Values of Autonomous Expenditures or the Stock of Money

$$C = a + KA + VM$$

Period	Constant term	Regression coefficient of (and its standard error)		
	a	A	M	R
Annual Figures				
1897 - 1958	8348.66	-.425 (.243)	1.380 (.047)	.986
1897 - 1908	3278.78	-.238 (.139)	1.690 (.052)	.997
1903 - 1913	574.677	-.057 (.050)	1.911 (.019)	.997
1908 - 1921	207.705	.181 (.126)	1.750 (.064)	.996
1913 - 1920	357.789	.287 (.274)	1.749 (.158)	.99[illegible]
1920 - 1929	15730.4	.239 (.300)	1.294 (.149)	.971
1921 - 1933	16891.88	.794 (.133)	1.138 (.150)	.978
1929 - 1939	32786.1	1.583 (.590)	.653 (.370)	.955
1933 - 1938	13826.75	.377 (.479)	1.129 (.240)	.992
1938 - 1953	1264.00	-.510 (.407)	1.333 (.114)	.963
1939 - 1948	22696.6	-.455 (.253)	1.029 (.090)	.975
1948 - 1957	-140155.6	.706 (.690)	2.110 (.182)	.991
1929 - 1958	-3321.58	-.866 (.356)	1.518 (.088)	.979
Quarterly Figures				
1945_{III}-1958_{IV}	-174895.	.064 (.205)	2.411 (.007)	.985

TABLE 2.II

Relations in Nominal Terms: Multiple or Simple Regression Equations Between Consumption or Income and Synchronous Values of Autonomous Expenditures or the Stock of Money

$$C = \alpha + KA$$

Period	Constant term (and its standard error) α	Regression Coefficient of A	r
Annual Figures			
1897 - 1958	32416.3 (8970.45)	5.162	.756
1897 - 1908	10744.9	2.564	.587
1903 - 1913	15873.0 (4456.62)	2.427	.485
1908 - 1921	22968.3	2.407	.672
1913 - 1920	21015.09 (7489.44)	2.606	.791
1920 - 1929	55133.5 (7244.35)	1.602	.569
1921 - 1933	58587.4	1.384	.843
1929 - 1939	58335.9 (1169.94)	2.498	.937
1933 - 1938	56504.0	2.452	.935
1938 - 1953	96791.5	1.864	.397
1939 - 1948	102057.8 (8291.39)	.494	.173
1948 - 1957	26341.4 (63464.72)	7.164	.747
1929 - 1958	68467.5 (16980.87)	3.944	.705
Quarterly Figures			
1945_{III}-1958_{IV}	124331. (22455.)	3.695	.511

TABLE 2.III

Relations in Nominal Terms: Multiple or Simple Regression Equations Between Consumption or Income and Synchronous Values of Autonomous Expenditures or the Stock of Money

$$C = \alpha + VM$$

Period	Constant term (and its standard error) α	Regression Coefficient of M	r
Annual Figures			
1897 - 1958	7812.15 (2472.42)	1.315	.985
1897 - 1908	3190.3	1.635	.996
1903 - 1913	533.612 (601.234)	1.900	.997
1908 - 1921	1427.4	1.810	.995
1913 - 1920	-123.296 (2443.68)	1.875	.991
1920 - 1929	15303.6 (4934.39)	1.357	.968
1921 - 1933	337.53	1.663	.897
1929 - 1939	-9432.974 (9453.36)	1.527	.912
1933 - 1938	7278.6	1.303	.991
1938 - 1953	-2434.5	1.262	.958
1939 - 1948	17438.1 (10055.7)	.976	.963
1948 - 1957	-140039.6 (18659.53)	2.230	.990
1929 - 1958	-1198.28 (6995.66)	1.351	.974
Quarterly Figures			
1945_{III}-1958_{IV}	-175088. (9668.)	2.422	.985

TABLE 2.IV

Correlations Between Synchronous Variables in Nominal Terms

Period	Income-Expenditure Theory		Quantity Theory			
	r_{CA}	$r_{CA.M}$	r_{CM}	$r_{CM.A}$	r_{YM}	r_{AM}
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Annually						
1897 - 1958	.756	-.222	.985	.967	.988	.791
1897 - 1908	.587	-.496	.996	.996	.991	.622
1903 - 1913	.485	-.127	.997	.996	.987	.495
1908 - 1921	.672	.400	.995	.993	.975	.646
1913 - 1920	.791	.423	.991	.980	.975	.761
1920 - 1929	.569	.288	.968	.956	.933	.524
1921 - 1933	.843	.884	.897	.923	.810	.586
1929 - 1939	.937	.688	.912	.529	.915	.880
1933 - 1938	.935	.414	.991	.938	.985	.921
1938 - 1953	.397	-.328	.958	.955	.966	.500
1939 - 1948	.173	-.562	.963	.974	.967	.327
1948 - 1957	.747	.361	.990	.980	.986	.719
1929 - 1958	.705	-.424	.974	.957	.983	.784
Quarterly						
1945_{III}-1958_{IV}	.511	.044	.985	.979	.980	.512
1946_{I}-1958_{IV}	.687	.286	.985	.973	.978	.660

in Table 2.V below, also confirm the dominance of money over autonomous expenditures. Holding both prices and autonomous expenditures constant, money and consumption are, overall, more highly correlated than are autonomous expenditures and consumption when prices and money are held constant.

In other experiments, the authors use quarterly data, in a seasonally adjusted form, to test for lagged relationships. They find, for example, that the simple correlation coefficient between C and M is highest when C is correlated with M two quarters earlier. See Table 2.VI below. The corresponding relationship between C and A is for the first quarter. In this case, the correlation becomes negative when the lead of A over C is extended beyond 4 quarters.

The authors carry this examination of the lagged relationship a step further, and consider the effect of M and A on the subsequent behaviour of C, by computing the multiple correlation equations between C and the values of M and A in a successively larger number of quarters. The results, shown in Table 2.VII below, show that the multiple correlation coefficient tends to rise only slightly when additional values of A are added, but tends to rise greatly as each additional value of M is added. According to F-M, these correlations provide evidence that the stock of money has an influence on later levels of consumption.

F-M also investigate further lagged effects by correlating C with prior values of both M and A. From the results, given in Table 2.VIII below, the authors find that the addition of prior values of A have no significant effect on the multiple correlation coefficient. The results of this estimation, according to the authors, reinforces the fact that the addition of autonomous expenditures does not alter the strong relationship between money and consumption.

TABLE 2.V

Correlations Between Synchronous Variables
in Real Terms

Period (1)	$r_{CA.P}$ (2)	$r_{CA.MP}$ (3)	$r_{CM.P}$ (4)	$r_{CM.AP}$ (5)	$r_{YM.P}$ (6)
Annual Figures					
1897 - 1958	.157	-.314	.878	.888	.901
1897 - 1908	.290	-.570	.911	.935	.910
1903 - 1913	.126	-.113	.918	.917	.757
1908 - 1921	-.673	-.443	.919	.880	.137
1913 - 1920	-.701	.662	.863	.848	.059
1920 - 1929	.611	.190	.970	.954	.944
1921 - 1933	.611	.387	.956	.940	.917
1929 - 1939	.909	.807	.946	.887	.912
1933 - 1938	.442	.097	.952	.940	.896
1936 - 1953	-.513	-.472	-.342	-.261	-.010
1939 - 1948	-.904	-.929	.083	.505	.287
1948 - 1957	-.606	.203	.856	.771	.781
1929 - 1958	-.207	-.352	.222	.360	.485
Quarterly Figures					
1945_{III}-1958_{IV}	.182	.021	.918	.915	.860
1946_{I}-1958_{IV}	.000	.020	.900	.809	.855

TABLE 2.VI

Simple Correlation Coefficients Between Lagged Variables

Quarterly Figures, 1945_{III} - 1958_{IV}

Dependent Variable	Independent Variable	Quarters of Lead of Independent Variable										
		0	1	2	3	4	5	6	7	8	9	10
C	A	.511	.328	.187	.074	-.005	-.088	-.155	-.208	-.238	-.284	-.314
C	M	.985	.988	.989	.988	.986	.982	.977	.971	.967	.962	.957
M	C	.985	.982	.979	.976	.974						
Y	M	.980	.981	.980	.977	.972	.966	.960	.954	.952	.947	.944
ΔC	ΔA	-.598	.162	-.173	-.377	.110	-.342	.258	-.114	.237	-.032	-.090
ΔC	ΔM	.296	.343	.215	.265	.225	.260	.177	.242	.105	.106	.227
ΔY	ΔM	-.047	-.038	-.135	-.177	-.167	-.095	-.271	-.075	-.072	-.159	-.138

TABLE 2.VII

Relations Involving Lagged Variables: Regression Equations Between Consumption or Income and Values of Autonomous Expenditures or the Stock of Money, in the Same and Earlier Quarters, Quarterly Figures, 1945_{III} - 1958_{IV}

Dependent Variable	Constant Term (and its standard error)	Regression Coefficient of (and its standard error)						R
		A_t	A_{t-1}	A_{t-2}	A_{t-3}	A_{t-4}	A_{t-5}	
C_t	124.33 (22.455)	3.695 (.863)						.511
C_t	128.04 (23.304)	4.316 (1.297)	-.759 (1.178)					.517
C_t	133.01 (23.617)	4.409 (1.296)	.337 (1.507)	-1.363 (1.175)				.535
C_t	137.18 (24.163)	4.230 (1.315)	.559 (1.533)	-.521 (1.528)	-1.029 (1.189)			.545
C_t	136.99 (25.520)	4.240 (1.389)	.557 (1.550)	-.529 (1.580)	-1.054 (1.549)	.031 (1.251)		.545
C_t	141.86 (26.073)	4.421 (1.404)	.057 (1.404)	-.506 (1.641)	-.727 (1.582)	1.026 (1.589)	-1.200 (1.279)	.556

Table 2.VII continued

Relations Involving Lagged Variables: Regression Equations Between Consumption or Income and Values of Autonomous Expenditures or the Stock of Money, in the Same and Earlier Quarters, Quarterly Figures, 1945_{III} - 1958_{IV}

Dependent Variable	Constant Term (and its standard error)	Regression Coefficient of (and its standard error)						R
		M_t	M_{t-1}	M_{t-2}	M_{t-3}	M_{t-4}	M_{t-5}	
C_t	-175.09 (9.668)	2.422 (.059						.985
C_t	-174.24 (8.772)	-.833 (.933)	3.278 (.938)					.988
C_t	-171.32 (8.500)	.859 (1.149)	-.874 (1.986)	2.450 (1.044)				.989
C_t	-166.92 (8.329)	1.230 (1.109)	.229 (1.953)	-1.525 (1.936)	2.478 (1.035)			.990
C_t	-161.70 (8.775)	1.371 (1.093)	.496 (1.926)	-1.078 (1.922)	-.052 (1.840)	1.464 (.998)		.991
C_t	-155.75 (8.558)	2.171 (1.072)	-.751 (1.873)	.122 (1.865)	.340 (1.739)	-2.077 (1.681)	2.545 (.953)	.992

TABLE 2.VIII

Relations Involving Lagged Variables: Regression Equations Between Consumption or Income and Values of Autonomous Expenditures or the Stock of Money, in the Same and Earlier Quarters, Quarterly Figures, 1945_{III} - 1958_{IV}

Dependent Variable	Constant Term (and its standard error)	Regression Coefficient of (and its standard error)										R
		M_t	A_t	M_{t-1}	A_{t-1}	M_{t-2}	A_{t-2}	M_{t-3}	A_{t-3}	M_{t-4}	A_{t-4}	
C_t	-174.89 (9.772)	2.411 (.070)	.064 (.205)									.985
C_t	-173.23 (8.952)	-1.112 (1.029)	.263 (.260)	3.518 (1.027)	-.036 (.228)							.988
C_t	-168.53 (8.536)	.591 (1.150)	.298 (.245)	-.577 (1.966)	.276 (.261)	2.364 (1.097)	-.306 (.216)					.990
C_t	-163.54 (8.161)	1.065 (1.088)	.246 (.230)	.166 (1.886)	.320 (.248)	-.906 (1.890)	.026 (.248)	2.028 (1.075)	-.334 (.207)			.992
C_t	-158.26 (8.565)	1.223 (1.128)	.219 (.239)	.326 (1.913)	.341 (.244)	-.552 (1.870)	.038 (.252)	-.391 (1.838)	-.171 (.247)	1.707 (1.126)	-.102 (.229)	.992

The authors compute relationships between the first differences of the variables, in an attempt to remove the effect of a common trend. The modified results tend to confirm the general conclusions and although the correlation coefficients are low, they are largest when changes in C are correlated with changes in M in the preceding quarter. No systematic pattern is found in the correlation between C and A, and both negative and zero correlation coefficients are encountered. These results are tabulated below in Table 2.IX.

The major implication of the F-M study is the conclusion that monetary policy is likely to be more predictable and to have a larger impact on income than autonomous expenditure. Some elaboration of this conclusion is necessary, especially in regard to the channels through which monetary policy has its ultimate effect on income. Again, the quantity theory and income-expenditure models are at odds.

In a Keynesian context, changes which occur in the money stock are transmitted to aggregate income via changes in interest rates. These changes in interest rates which form the *transition mechanism*, affect the level of investment spending which, in turn, affects the income aggregates by way of the multiplier process. On the other hand, the quantity theory assumes that the public has some desired stock of money relative to its income. Any alteration to the stock of money alters this desired ratio and induces a response by the public which will be aimed at restoring the desired relationship.

It is this response which is the source of changes occurring in the level of income. In comparison with the Keynesian 'credit' view therefore, the quantity theory approach suggests that changes in the stock of money operate through a whole range of expenditures rather than simply through changes in investment expenditures.

TABLE 2.IX

Relations Involving Lagged Variables: Regression Equations Between First Differences of Consumption or Income and First Differences of Values of Autonomous Expenditures or the Stock of Money for the Same and Earlier Quarters, Quarterly Figures, 1945_{III} - 1958_{IV}

Dependent variable	Constant Term (and its standard error)	Regression Coefficient of (and its standard error)						R
		ΔA_t	ΔA_{t-1}	ΔA_{t-2}	ΔA_{t-3}	ΔA_{t-4}	ΔA_{t-5}	
ΔC_t	21.079 (1.486)	-.390 (.072)						.598
ΔC_t	20.176 (2.288)	-.383 (.074)	.039 (.074)					.601
ΔC_t	21.309 (2.779)	-.377 (.075)	.030 (.076)	-.055 (.075)				.606
ΔC_t	25.075 (2.816)	-.333 (.070)	.061 (.070)	-.096 (.070)	-.225 (.071)			.600
ΔC_t	25.729 (3.164)	-.339 (.072)	.067 (.072)	-.090 (.072)	-.230 (.072)	-.034 (.073)		.692
ΔC_t	27.602 (3.352)	-.326 (.071)	.052 (.072)	-.072 (.072)	-.213 (.072)	-.050 (.073)	-.111 (.073)	.709

Table 2.IX continued

Relations Involving Lagged Variables: Regression Equations Between First Differences of Consumption or Income and First Differences of Values of Autonomous Expenditures or the Stock of Money for the Same and Earlier Quarters, Quarterly Figures, 1945_{III} - 1958_{IV}

Dependent Variable	Constant Term (and its standard error)	Regression Coefficient of (and its standard error)						R
		ΔM_t	ΔM_{t-1}	ΔM_{t-2}	ΔM_{t-3}	ΔM_{t-4}	ΔM_{t-5}	
ΔC_t	11.193 (1.057)	.889 (.397)						.297
ΔC_t	10.620 (1.107)	.405 (.502)	.706 (.457)					.359
ΔC_t	10.695 (1.159)	.420 (.510)	.777 (.546)	-.115 (.472)				.360
ΔC_t	10.590 (1.173)	.409 (.513)	.694 (.560)	-.309 (.545)	.321 (.444)			.373
ΔC_t	10.567 (1.190)	.382 (.533)	.713 (.573)	-.339 (.568)	.267 (.517)	.098 (.469)		.374
ΔC_t	10.494 (1.216)	.420 (.548)	.650 (.602)	-.315 (.577)	.194 (.577)	.002 (.539)	.192 (.513)	.377

The F-M study supports the monetarist position; the results suggest that the monetary instruments are the more effective vehicle of policy. They also suggest that the quantity theorists' view of the operation of monetary policy is to be preferred to the Keynesian 'credit' argument. Changes in the money supply work *directly* on aggregate expenditure and are not transmitted to expenditure through the interest rate.

2.1.1 <u>Criticisms of the F-M approach</u>

The large number of articles which followed publication of the F-M results is proof of the immense interest evoked by this study.[2] In a survey of the criticisms and weaknesses of the F-M approach, Stephanie Edge concludes that the overall result of the original and subsequent studies is to lead the authors and others, 'into an economic cul-de-sac' [19, p. 68]. The major criticisms of the F-M approach relate to the various definitions of both money and autonomous expenditures. In addition, there are criticisms of the inclusion or exclusion of particular time periods, and the problems caused by the estimation procedure.

It is in the definition of the autonomous expenditure variable that many consider the F-M analysis to be weakest. The majority of the critics maintain that nearly all the components of F-M's definition of autonomous expenditure are, in fact, endogenous, and should be eliminated from the final definition. Perhaps the main reason for this criticism

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2. Some of the studies and criticisms which followed from the initial F-M work are listed in the bibliography at the end of this chapter. See [12], [13], [25], [31], [32], [35], [36], [41], [42].

is the statistical criteria used by F-M in determining the exogeneity, or otherwise, of the various components of autonomous expenditure [20, pp. 182-185]. Lewis [34] considers in detail the selection process used by F-M, and amongst others, Edge [19, pp. 65-67] suggests that the authors are not always consistent in applying their criteria.

In his comment on the F-M paper, Donald Hester [25] argues that F-M have represented the autonomous expenditure theory in an unorthodox form which makes it very sensitive to statistical comparison. He maintains that the inclusion of the government deficit and the net foreign balance in A is not entirely correct, and that these two variables are not likely to be completely exogenous.

In an attempt to improve the definition of A, Hester employs a simple model which recognizes the dependence of taxes on income. This is done in order to alleviate the alleged weakness in F-M's definition which, Hester argues, ignores the fact that taxation is a function of income. From his model, Hester considers four measures of A:

$$L = I + G + H - \bar{M}$$

$$L' = L + \bar{M} + D$$

$$L'' = L' - \bar{M}$$

$$L''' = L' - E$$

where I = net private domestic investment

G = government expenditure on income and product account

H = exports

$\bar{M}$ = imports

D = capital consumption allowances

E = change in inventories.

In computing correlation coefficients to test the new definitions for the period 1929-58, Hester finds that, with the exception of the 1929-39 period, the correlation between C and every proposed measure of A exceeds the corresponding correlation between C and F-M's definition of A. He also finds that the correlations between C and any of the proposed definitions of A do not differ from the correlations between C and M by more than 0.06 for the 30-year time period studied.

In reply to Hester's criticisms, F-M [21] criticise Hester's use of a limited time period. They maintain that, if the World War II years are excluded, almost half of Hester's test period is made up of the years 1929-39 which they originally considered to be a period substantially different from other periods.

Ando and Modigliani (hereafter referred to as A-M) [9] also attempt to call attention to a number of basic shortcomings in the F-M paper. Making use of a full scale set of definitional expressions and identities, A-M test a consumption-autonomous expenditure relationship once again using a drastically altered definition of autonomous expenditure.[3]

The equation tested fits the data well, and the fitting of a correlation between C and the newly defined autonomous expenditure

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3. Their definition comprises net investment in plant, equipment, and residential houses, total government purchases of goods and services, exports, the property tax portion of indirect business taxes, net investment paid to government, government transfer payments (i.e. unemployment insurance benefits), subsidies less current surplus of government enterprises, less the excess of wage accruals over disbursement. This can be compared to F-M's original definition given in footnote 1 above. See p. 11.

variable reduces the unexplained variance by 90 per cent when compared with the original F-M equation.

In another major attack on the F-M paper, de Prano and Mayer [17] (hereafter referred to as D-M) submit further alternative definitions of A, using different selection techniques from those used by F-M. They suggest that the definition of A used by F-M (consisting of the sum of fixed private domestic investment, government deficit on income and product account, and the net foreign balance) contain endogenous elements. To show this, D-M correlate the various components of F-M's definition of A with C to show how the correlation coefficient falls as non-endogenous components are added. From this test, the authors conclude that three components - inventory investment, imports, and the government deficit or surplus - are, in fact, endogenous.

D-M suggest that the new definitions of A[4] used, tend to perform much better than the definition used by F-M in their tests.

The other major definitional criticism of the F-M approach concerns their choice of M, the monetary variable. Ando and Modigliani [9, p. 708], for example, suggest that, during the period tested by F-M, the variable M used was at least partly induced, and thus positively correlated with the error term in the tested equation. These authors maintain that there are adequate grounds for suggesting that the causal links from the money supply to money income are more complex than F-M's analysis suggests. The high correlations obtained by F-M for the

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4. A as the sum of investment in producers' durable equipment, non-residential construction, residential construction, federal government expenditures on income and product account and exports.
A as the above definition less capital consumption measures.
A as gross fixed private domestic investment.
A as gross fixed private domestic investment plus exports.

monetary variable may actually overstate the strength of the causal mechanism from the money supply to the level of income. Because of this fact, A-M experiment with another monetary variable, M*, which they define as the estimated maximum amount of money that could be created by the banking system on the basis of the monetary authorities' reserves, taking into account the reserve requirements and currency holding habits of this authority. This approach is based on the somewhat dubious assumption that the bank's reserves are autonomous. In fact, it has been suggested that because deficit financing serves to increase bank reserves, M* is related to A, and this definition of a new monetary variable does not improve the F-M approach greatly [19, p. 59].

Other studies which attempt to redefine the monetary variable also base their criticism of the F-M definition on the fact that such a variable may not be truly autonomous. The studies by Barrett and Walters [12] and Laumas and Laumas [31] highlight the fact that critics of the F-M approach recognize the problem of exogeneity in the definition of the monetary variable. Barrett and Walters examine the possibility of a lag existing in the effect of money on consumption. Such an analysis is pursued with the aid of Friedman's 'permanent income' hypothesis. Despite their exhaustive study, the authors are unable to conclude that *only* money or *only* autonomous expenditures are the predominant variable influencing income. They find that money is relatively more important in the full employment years leading up to World War I, and autonomous expenditures account for most of the changes in consumption in the high unemployment years between the wars. Laumas and Laumas, similarly, are unable to come to any definite conclusion concerning the relative importance of M and A, despite a detailed monetary analysis aimed at improving the F-M definition. The basis of this particular approach is a test of the so-called 'degree of moneyness' of various monetary definitions [30]. This approach merely leads to the conclusion that both A and the newly defined M are equally important in determining income, and that their relative importance depends upon the period considered.

The use of time periods differing in length is also the individual subject of debate on the Friedman-Meiselman paper. The authors themselves consider the entire period from 1897 to 1958, but ignore many of the results of the Depression years because they do not accord with their overall results and because they consider the period to be one characterized by breakdowns in the banking and financial system which would adversely affect the monetary mechanisms. In this regard, it is worthwhile noting that the inclusion of the War years in the Friedman-Meiselman study has no detrimental effects on the obviously overwhelming superiority of the quantity theory in determining economic activity. Many of the critics of F-M's selected time period criticise the inclusion of the war years which bias the results in favour of the monetarist case because war time rationing produces a spasmodic pattern of consumption.

Other antagonists of the F-M approach also attack the estimation process on the grounds of the presence of distortion due to autocorrelation. However, much of the criticism in this regard is obviated by the fact that F-M also estimate their results in terms of first differences. This is an attempt by the authors to eliminate the presence of a common trend, but, unfortunately, the results prove less than conclusive. Other critics of the F-M approach are also less than conclusive in their attempts to solve this problem.[5]

One further criticism of the F-M approach stems from the author's use of a simple one-equation model to test the competing theories. Ando and Modigliani [9, pp. 714-16] are among the critics who question the meaning and relevance of simply comparing the correlation coefficients for the variables A and M. They suggest that the F-M approach fails to shed any light on the problem of how the dependent variable, either C or Y, can be effectively controlled. This failure stems from two fundamental flaws in the F-M approach which have, as their basis, the use of the simple single equation model.

Firstly, A-M argue that there is no justification for the treatment of the autonomous expenditure variable and the money supply variable as mutually exclusive stabilization devices. In fact it is more accurate to suggest that the quantity theory is a theory of demand for money and, as such, is an important part of the Keynesian framework of income determination.

Secondly, and more importantly in the context of the following chapter of this thesis, A-M suggest that neither of the two rival theories tested can be properly regarded as a behavioural or structural relation. Even if the independent variables used in the tested equations can be regarded as truly exogenous, at best they can be regarded as 'grossly misspecified "reduced forms"' [9, p. 715]. A-M, however, fail to agree that the independent variables can be regarded as truly exogenous.

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5. For example, Ando and Modigliani utilize the 'permanent income' hypothesis with the incorporation of a lagged consumption variable.

At best, they argue, the independent variables can be regarded as 'autonomous' in the sense of being uncorrelated with the error term of the test equation. Such a situation is quite different from being exogenous in the economic sense. This particular problem, along with several others inherent in the F-M approach, also appear in the later monetary-fiscal studies of Andersen and Jordan [6]. The first article which appears to fully recognize the consequences of incorrectly treating endogenous variables as exogenous is the study by Goldfeld and Blinder [23] who analyse closely many of the erroneous conclusions which may be reached under these circumstances. The general problem of endogeneity and the points raised by Goldfeld and Blinder are discussed in Chapter 3.

2.2 The Andersen-Jordan study

The study by Andersen and Jordan (hereafter referred to as A-J) represents a step forward in the monetarist argument.

The basic thrust of the A-J approach is to place more emphasis on the relative attributes of monetary and fiscal *policy*, rather than merely attempting to examine the relative influences of money and autonomous expenditures in influencing income movements. Their study sets out to examine whether or not the response of economic activity to fiscal actions is (i) greater in effect; (ii) more predictable and (iii) induces a more rapid response, than the response to monetary policy. They do not experiment with structural forms. For example, they do not test for the directness or indirectness of monetary actions upon the aggregates.

The measure of economic activity used in this study is GNP at current prices. Two measures of monetary actions are used by the authors; the monetary base and the money stock. The monetary base, which is assumed to be under the direct control of the monetary authorities, is defined to include reserve deposits of member banks at the Reserve Bank and all currency held by commercial or non-banks, adjusted for changes in reserve requirements. Andersen and Jordan, in an earlier article [7] examine the concept of the monetary base in more detail. They consider the base to be a good measure of monetary influence for two reasons. Firstly, it acts as an important link between monetary authority actions and their impact on economic activity, and secondly, it is considered to be a variable over which the monetary authorities have the most complete control.

The two monetary measures are chosen because of their strategic importance in both the Keynesian and the Quantity theory approaches to explaining movements in economic activity. The channels through which the two schools view the influence of monetary policy have been examined previously[6] in relation to the stock of money. The use of the monetary base simply adds a further stage of influence in that changes in the monetary base engender changes in the money stock which, in turn, affect prices, interest rates and spending in general over a wide range of capital and consumer goods.

Turning to a measure of fiscal influence, A-J suggest the use of so-called 'high employment' budget concepts. These comprise both expenditures (goods and services and transfer payments) and receipts (legislated changes in Federal Government tax rates) which are adjusted for the influence of economic activity. The full employment budget

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6. p.23 above.

surplus (receipts less expenditures) is also used. To test the empirical relationships, quarter-to-quarter changes in GNP are regressed on quarter to quarter changes in the money stock and the various measures of fiscal policy. The various equations tested are as follows:

$$\Delta GNP_t = a_0 + a_1 \Delta M_{t-n} + a_2 \Delta (R - E)_{t-n} \tag{2.10}$$

$$\Delta GNP_t = b_0 + b_1 \Delta M_{t-n} + b_2 \Delta E_{t-n} + b_3 \Delta R_{t-n} \tag{2.11}$$

$$\Delta GNP_t = c_0 + c_1 \Delta M_{t-n} + c_2 \Delta E_{t-n} \tag{2.12}$$

$$\Delta GNP_t = d_0 + d_1 \Delta B_{t-n} + d_2 \Delta E_{t-n} + d_3 \Delta R_{t-n} \tag{2.13}$$

where GNP = Gross National Product at constant prices

M = money stock

R = high employment Government receipts

E = high employment Government expenditure

B = monetary base

and n = 1, 2 and 3 periods.

The changes in the variables are calculated using conventional 'first differences' by subtracting the value from the previous quarter from the value for the present quarter. An averaging procedure known as 'central differences' is also used. This method necessitates the summation of the forward difference and the backward difference which, according to Kareken and Solow [26], gives a better approximation of a smooth rate of change at any point of time. The above equations [(2.10) to (2.13)] are therefore estimated for variables calculated by both the normal 'first differences' and the 'central differences' methods.

The Almon lag structure [1] is used to estimate the structure of the lags present in the regressions. A-J's procedure, however, necessitates the *a priori* imposition of the lag length, even though the actual lag structure is determined by the regression itself, rather than being imposed *a priori*.

In terms of the R^2 statistic (adjusted for degrees of freedom) the results obtained fit well. The authors find that the estimated coefficients for both the money stock and the monetary base are highly significant and of the correct sign, whereas the estimated coefficients for the high employment measures of fiscal performance are not significant and tend to vary in sign. The results, using first difference and central difference techniques, are tabulated below in Table 2.X.

The monetary measures of either the money stock or the monetary base perform extremely well, and are highly significant over the four quarter lag distribution. On the other hand, as the table above displays, all measures of fiscal action fail to generate significant results. In fact, in the case of high employment expenditures, it is shown that an increase in Government expenditure is mildly stimulative in the quarter in which the increase occurs, but becomes negative in the second and third quarters.

The authors then use the results obtained from their estimations to test the propositions put earlier that fiscal actions are greater, more predictable and faster acting than monetary actions. In order to test the strength of the fiscal and monetary actions, the authors make use of 'beta coefficients' for their comparison, rather than the simple regression coefficients as tabulated in Table 2.X below. The beta coefficients are used to take account of past variation of changes in each independent variable relative to the past variation in GNP. The results of the conversion to beta variables are given in Table 2.XI

TABLE 2.X

Regression of Changes in GNP on Changes in Monetary and Fiscal Actions

First	(Equation 2.10)		(Equation 2.11)			(Equation 2.12)		(Equation 2.13)		
Differences	ΔM	Δ(R-E)	ΔM	ΔE	ΔR	ΔM	ΔE	ΔB	ΔE	ΔR
t	1.57*	-.15	1.51*	.36	.16	1.54*	.40	1.02	.23	.52
	(2.17)	(.65)	(2.03)	(1.15)	(.53)	(2.47)	(1.48)	(.49)	(.67)	(1.68)
t-1	1.94*	-.20	1.59*	.53*	-.01	1.56*	.54*	5.46*	.37	.02
	(3.60)	(1.08)	(2.85)	(2.15)	(.03)	(3.43)	(2.68)	(3.37)	(1.36)	(.07)
t-2	1.80*	.10	1.47*	-.05	-.03	1.44*	-.03	6.48*	-.21	-.17
	(3.37)	(.55)	(2.69)	(.19)	(.10)	(3.18)	(.13)	(4.10)	(.84)	(.64)
t-3	1.28	.47*	1.27*	-.78*	.11	1.29*	-.74*	3.05	-.93*	.14
	(1.88)	(1.95)	(1.82)	(2.82)	(.32)	(2.00)	(2.85)	(1.54)	(3.10)	(.39)
Sum	6.59*	.22	5.84*	.07	.23	5.83*	.17	16.01*	-.54	.51
	(7.73)	(.45)	(6.57)	(.13)	(.32)	(7.25)	(.54)	(5.67)	(.89)	(.67)
Constant	1.99*		2.10			2.28*		1.55		
	(2.16)		(1.88)			(2.76)		(1.22)		
R^2	.56		.58			.60		.53		
S.E.	4.24		4.11			4.01		4.35		
D-W	1.54		1.80			1.78		1.71		

TABLE 2.X (Continued)

Central Differences	(Equation 2.10) ΔM	(Equation 2.10) $\Delta(R-E)$	(Equation 2.11) ΔM	(Equation 2.11) ΔE	(Equation 2.11) ΔR	(Equation 2.12) ΔM	(Equation 2.12) ΔE	(Equation 2.13) ΔB	(Equation 2.13) ΔE	(Equation 2.13) ΔR
t	1.50	-.24	1.58*	.53	.32	1.54*	.63*	.61	.28	.87*
	(1.84)	(.91)	(2.01)	(1.52)	(1.05)	(2.45)	(2.21)	(.28)	(.73)	(2.55)
t-1	2.11*	-.23	1.57*	.60	-.04	1.63*	.59*	5.42*	.50	-.07
	(3.61)	(1.16)	(2.78)	(2.44)	(.17)	(3.57)	(2.61)	(3.16)	(1.87)	(.27)
t-2	1.89*	.15	1.41*	-.15	-.11	1.43*	-.16	6.87*	-.27	-.33
	(3.18)	(.81)	(2.45)	(.60)	(.47)	(3.16)	(.71)	(3.92)	(1.04)	(1.31)
t-3	1.06	.52	1.26	-.96*	.18	1.13	-.86*	3.51	-1.26*	.35
	(1.36)	(1.90)	(1.72)	(3.15)	(.48)	(1.71)	(3.07)	(1.71)	(3.65)	(.87)
Sum	6.56*	.21	5.80*	.02	.34	5.74*	.19	16.41*	-.75	.82
	(8.16)	(.47)	(7.57)	(.04)	(.54)	(8.45)	(.77)	(6.95)	(1.37)	(1.16)
Constant	2.02*		2.00*			2.30*		1.24		
	(2.48)		(2.14)			(3.55)		(1.14)		
R^2	.66		.72			.73		.67		
S.E.	3.35		3.03			2.97		3.26		
D-W	.88		1.14			1.13		1.05		

Note: Regression coefficients are the top figures, and their 't' values appear below each coefficient enclosed by parentheses.
The regression coefficients marked by an asterisk (*) are statistically significant at the 5 percent level. R^2 are adjusted for degrees of freedom.
S.E. is the standard error of the estimate, and D-W is the Durbin-Watson statistic.

TABLE 2.XI

Measurements of the Relative Importance of Monetary and Fiscal Actions

First Differences (Equations 2.11 and 2.13)

	Beta Coefficients						Partial Coefficients of Determination					
Quarter	ΔM	ΔE	ΔR	ΔB	ΔE	ΔR	ΔM	ΔE	ΔR	ΔB	ΔE	ΔR
t	.24	.14	.05	.06	.09	.16	.07	.02	.01	*	.01	.05
t-1	.26	.20	*	.31	.14	.01	.14	.08	*	.18	.03	*
t-2	.24	-.02	-.01	.37	-.08	-.05	.12	*	*	.24	.01	.01
t-3	.20	-.30	.03	.17	-.36	.04	.06	.13	*	.04	.16	*
Sum	.94	.02	.07	.91	-.21	.16	.45	*	*	.38	.02	.01

Central Differences (Equations 2.11 and 2.13)

	Beta Coefficients						Partial Coefficients of Determination					
	ΔM	ΔE	ΔR	ΔB	ΔE	ΔR	ΔM	ΔE	ΔR	ΔB	ΔE	ΔR
t	.26	.20	.09	.04	.11	.25	.07	.04	.02	*	.01	.11
t-1	.26	.23	-.01	.31	.19	-.02	.13	.10	*	.16	.06	*
t-2	.23	-.06	-.03	.40	-.10	-.09	.11	.01	*	.23	.02	.03
t-3	.20	-.36	.05	.20	-.47	.10	.05	.16	*	.05	.21	.01
Sum	.95	.01	.10	.95	-.27	.24	.53	*	.01	.49	.04	.03

* Less than .005.

above, for the monetary variables, and the fiscal expenditure and receipts variables.

The results above indicate quite conclusively that changes in the money variables generally have a greater impact on GNP than changes in the fiscal high employment variables for the current period and the two quarters preceding the change. In those cases where ΔE provide the greater beta coefficient, it is associated with a negative coefficient sign, indicating a contractionary effect.

Partial coefficients of determination[7] are used to check the results for this proposition, and these tend to coincide with the former results. See Table 2.XI. From these tests, the authors are unable to confirm the first proposition that fiscal actions are stronger than monetary actions.

The second proposition, that the response of economic activity to fiscal actions is more predictable than the response to monetary influences, is tested by a comparison of the t-values (the value of the regression coefficient relative to its standard error). The higher the value of the t-ratio, the greater the reliability of the estimated change in GNP resulting from a change in the variable.

The two monetary variables outperform the fiscal high expenditure variables in all quarters, except the third. See Table 2.XII below. The t-values for the sum of the regression coefficients are extremely large for both ΔM and ΔB, but are not statistically significant for the ΔE variable. Accordingly, the second proposition is not confirmed.

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7. These measure the percent of variation of the dependent variable remaining after the variation due to other variables in the regression has been subtracted.

TABLE 2.XII

Measurement of Reliability of the Response of GNP to Monetary and Fiscal Actions

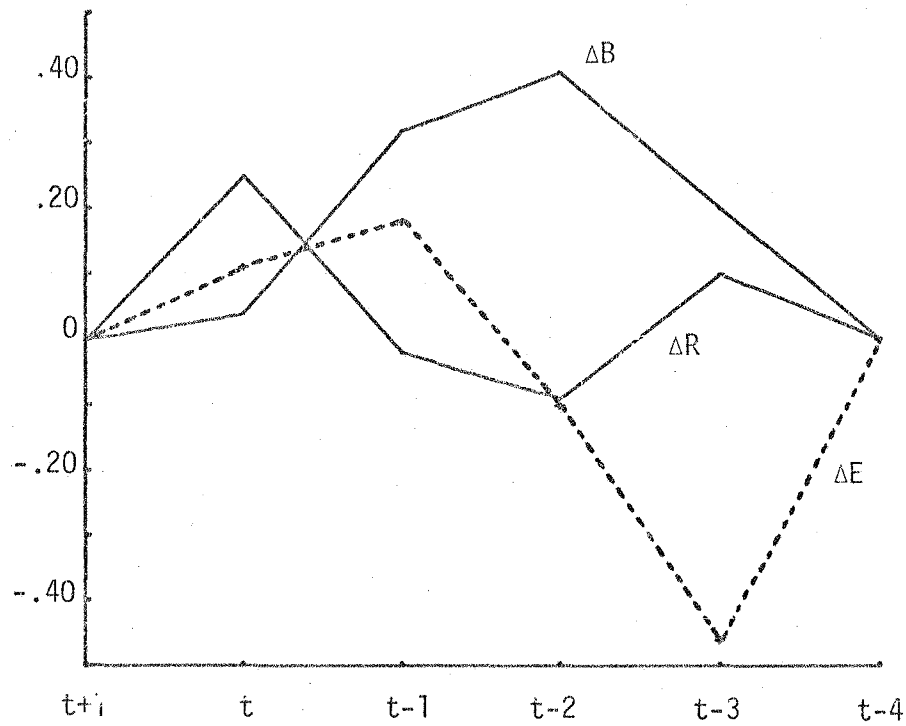
("t-values" of Regression Coefficients[a])

Quarter	First Differences					
	ΔM	ΔE	ΔR	ΔB	ΔE	ΔR
t	2.03	1.15	0.53	0.49	0.67	1.68
t-1	2.35	2.15	0.03	3.37	1.63	0.07
t-2	2.69	0.19	0.10	4.10	0.84	0.64
t-3	1.82	2.82	0.32	1.54	3.10	0.39
sum	5.57	0.13	0.32	5.67	0.89	0.67
	Central Differences					
Quarter	ΔM	ΔE	ΔR	ΔB	ΔE	ΔR
t	2.01	1.52	1.05	0.28	0.73	2.55
t-1	2.78	2.44	0.17	3.16	1.87	0.27
t-2	2.45	0.60	0.46	3.92	1.04	1.31
t-3	1.72	3.15	0.48	1.71	3.65	0.87
sum	7.57	0.04	0.54	6.95	1.37	1.16

a. t-values associated with equations (2.11), (2.13) for both first differences and central differences in Table 2.X.

The third proposition concerning the speed of response of the fiscal and monetary variables is tested by comparing the lag structure of the regressions primarily in terms of the size of the beta coefficients in the quarter of the change and the quarter following the change. A-J plot the beta coefficients (see Figures 2(1) and 2(2) below) and conclude that a change in M induces a large and equal response over the four quarters. A change in B induces the largest response in the first

Figure 2(1)
Central Differences
Equation 2.13



Equation 2.11

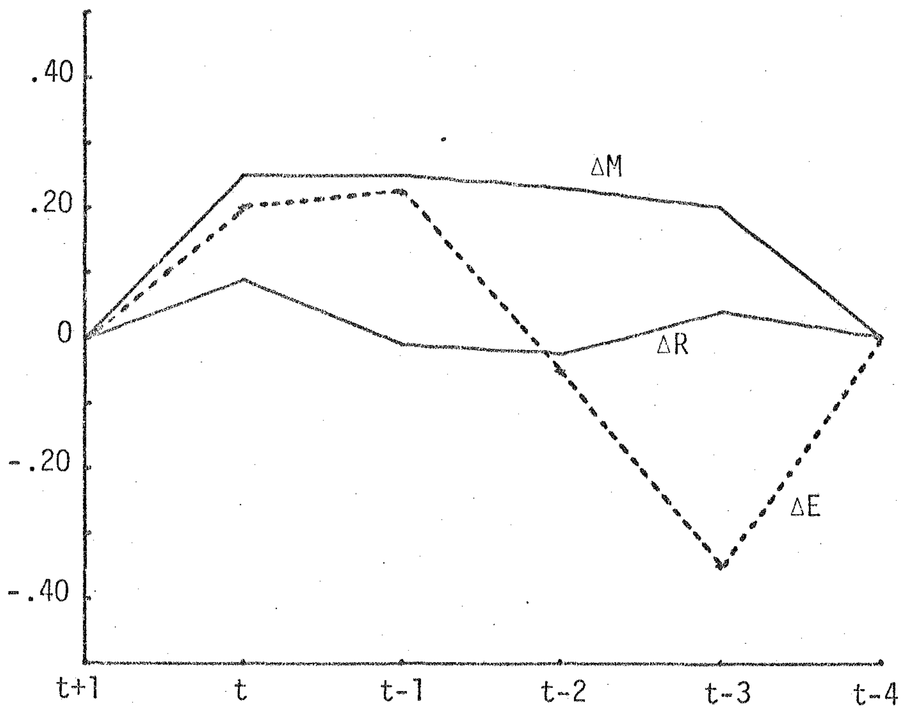
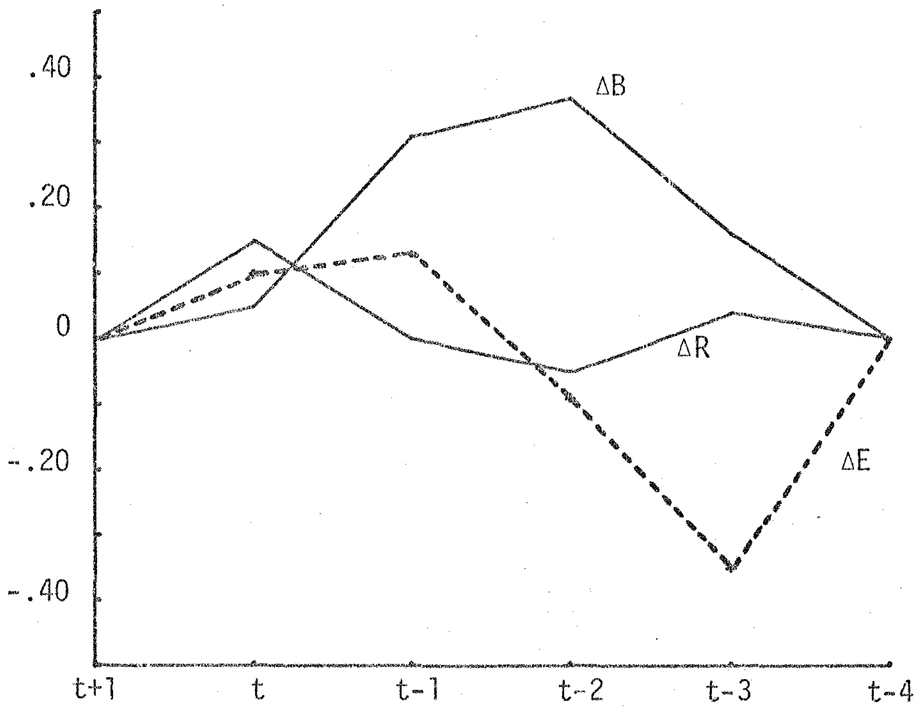
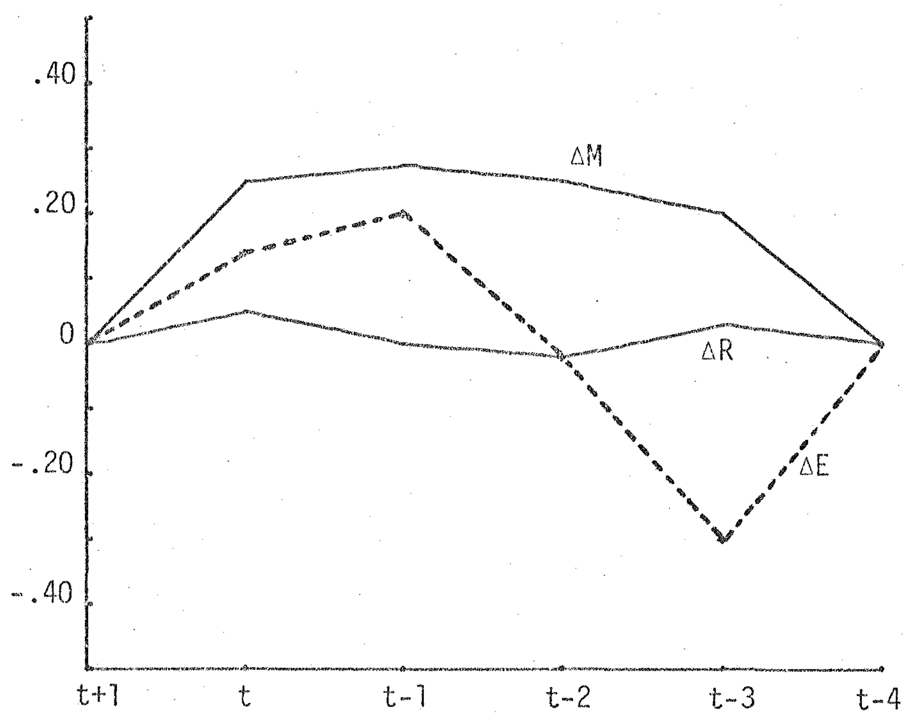


Figure 2(2)
First differences
Equation 2.13



Equation 2.11



two quarters and a change in E is greatest in only the third quarter. Accordingly, A-J were unable to confirm that the major impact of fiscal policy on economic activity occurs within a shorter time period when compared with monetary policy.

In discussing the implications of the three propositions tested in the study, the authors basically conclude that monetary actions play a highly prominent role in economic stabilization. Evidence tends to suggest that the money stock is an important indicator of the general thrust of stabilization actions, basically because any changes in this variable reflect the discretionary actions of the monetary authorities in their use of the major instruments of policy.

Two Australian studies which have adopted the A-J approach are those of Dewald and Kennedy [18] and Sheppard [44]. Dewald and Kennedy duplicate the A-J study for Australia and find support for both monetary and fiscal influences, especially when unlagged equations are analysed. Using the Almon lag technique and either M_1, M_2 or M_3 as the monetary variable, the authors find that the evidence overwhelmingly supports the monetarist position.

Sheppard duplicates Argy's [10] reduced form approach, regressing annual percentage changes in GNP against annual percentage changes in M_1 and M_2 for the period 1950-1972. He finds that, by altering Argy's time period, he obtains results which again support the monetarist view. Sheppard then estimates regressions with quarterly percentage changes in nominal, real and nominal less real GNP against quarterly changes in M_1 and M_3 for the period 1959(4) - 1972(4). Using the Almon lag technique with a third degree polynomial, Sheppard finds a strong association in the current and first lagged period between the money supply and GNP. He admits that there is a possibility that some of this association may be due to a reverse causation from economic activity to money, although he also points out that much of the fluctuation in the monetary aggregates is the result of policy actions rather than the result of a simple 'accommodating' policy.

Sheppard also duplicates the A-J approach using either M_1 or M_3 as the monetary indicator, and Commonwealth Government spending, full employment Government receipts and exports as the fiscal indicators. The period covered is 1959(4) - 1972(1). In all cases, the fiscal indicators prove insignificant, whereas the money supply variable is highly significant.

2.2.1 Criticisms of the A-J approach

In general, the A-J approach manages to accommodate many of the criticisms of the F-M study. They overcome the criticism of the time period and the problem of trends caused by F-M's use of levels for the variables by using post-war quarterly first differences of data. Also, they use 'high employment' fiscal variables, carefully choosing the components of each so as to do away with the arbitrary endogenous-exogenous allocation which was roundly criticised in the F-M study. The same principles are applied to the choice of a monetary variable, where both the money stock and the monetary base are used. A-J attempt to alleviate endogeneity in these variables by giving results of their estimations for both the money stock and the monetary base.

Gramlich [24] maintains that the A-J study tends to alleviate, by concession, many of the stumbling blocks thrown up in the F-M study. However, as Gramlich also emphasizes, there has obviously been little progress made, or concession granted by way of determining a truly exogenous monetary or fiscal variable. Gramlich suggests that the problem is quite intractable, since 'it depends (as far as monetary policy is concerned) on, first, whether the Federal Reserve is really exogenous in its short-run response to movements in aggregate demand, and, secondly, on how this exogeneity can best be represented'. [24, p. 512] In this respect Gramlich touches on a point which is central to the whole problem surrounding monetary policy and the tests of its effectiveness and impact. He points out that the problem of endogeneity can only be important in those cases where the authorities are not constrained by competing objectives and where their actions are an immediate response to stabilization needs.

Despite these obvious improvements on the F-M approach, the large number of articles which have followed the publication of the A-J study emphasize the fact that the problems of testing monetary and fiscal policy strengths still exist. For example, in a comment on the A-J study, Frank de Leeuw and John Kalchbrenner [16] make use of alternative equations which, they suggest, appear to cast doubt on the A-J results.

The main basis of the criticism by de Leeuw and Kalchbrenner is the fact that A-J are not strict enough in using policy variables which are free from the influence of current movements in economic activity. Because of this fact, they argue that the model used does not employ variables which are strictly exogenous in terms of being subject to control by policy makers and also unresponsive to current endogenous forces. In this respect they are critical of A-J's use of the tax receipts variable, and the monetary base variable. In order to remove some of the influence of current movements in the price level on tax receipts (which would make them endogenous) de Leeuw and Kalchbrenner adjust the receipts in period (t-1) to current prices by multiplying full employment receipts by P_t/P_{t-1}. They then subtract this result from the current figure to get the difference in full employment receipts expressed in current year prices.

In addition, the authors delete borrowed reserves and currency from the monetary base, in order to eliminate endogenous movements in these items. Using these adjustments de Leeuw and Kalchbrenner find that the fiscal variables are generally more significant and the monetary variables less so.

Davis [15] questions the realism of A-J's paper for several reasons:

(i) the fiscal multipliers are virtually zero. He contrasts these to the results obtained from the FRB-MIT model where these same multipliers were found to exceed 3 after one year;

(ii) the monetary variable explains an unreasonable percentage of the variance of quarterly changes in GNP;

(iii) the monetary multiplier is too high to be realistic;

(iv) the money policy instrument works with an unrealistic speed.

One of the common criticisms of the A-J study is the argument that the money stock is influenced by economic activity. Because of this fact, it may be very difficult to identify the response of GNP to changes in money stock. This so-called 'reverse causation' argument is tested by Davis and he concludes that the association between changes in money and changes in GNP is not due primarily to the presence of the reverse causation effect. Further analysis of this reverse causation argument is also attempted by Andersen [2] who tests four hypotheses which, he maintains, are crucial in supporting the original A-J study.[8] These hypotheses are as follows:

(i) that changes in GNP have a greater influence on changes in money than do changes in the monetary base. The relationship tested is

$$\Delta M_t = a_0 + a_1 \Delta GNP_{t-n} + a_2 \Delta B_{t-n} \tag{2.14}$$

(ii) that changes in GNP have a greater influence on changes in the monetary multiplier than do changes in the monetary base. The relationship tested is

$$m = b_0 + b_1 \Delta GNP_{t-n} + b_2 \Delta B_{t-n} \tag{2.15}$$

(iii) that changes in GNP have a significant effect on the monetary base. The relationship tested is

$$\Delta B_t = c_0 + c_1 \Delta GNP_t \tag{2.16}$$

for two subperiods and the total time period.

Andersen finds that, in regard to the first hypothesis, ΔB has a much larger overall impact on ΔM than does ΔGNP. Secondly, he finds that neither ΔGNP nor ΔB have much influence on the monetary multiplier. Thirdly, a positive but varying relationship is found between ΔGNP and ΔB, but the direction of causation is not clear. Only in the second

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8. See Appendix 2A for a discussion of the Brunner Metzler framework on which Andersen's tests are based.

subperiod is there a significant relationship between ΔB and ΔGNP, and a significant shift in the relationship is detected between the two subperiods. This finding leads Andersen to test one further hypothesis:

(iv) that the response of GNP to changes in money will be greater in the subperiod where there is a greater response of the base to changes in GNP.

Andersen finds in this case that the regression coefficients are almost identical for the two subperiods and that there is no sign of any significant shift in the relationship between the two subperiods. From these tests, Andersen concludes that, even though there is support for the idea that ΔB responds to ΔGNP, the variations in this relationship are not accompanied by corresponding changes in the regression coefficients which relate ΔGNP to ΔM. For these reasons, Andersen rejects the 'extreme' version of the reverse causation argument. He maintains that the money stock cannot be said to respond to changes in economic activity to the extent that it would cast doubt on the validity of the A-J equation.

Despite this evidence, it can be concluded more realistically, that the A-J approach is subject to the same criticism as the F-M approach on one important issue - the assumption that monetary policy is exogenous.

One of the other major criticisms of the A-J approach (and the F-M approach) is the use of the simplified 'reduced form' method of estimation. Several critics suggest that it is better to make use of a structural model in the analysis of monetary and fiscal policy action. Such an approach has several advantages and disadvantages which will be discussed in section 2.3 below.

On the other hand, one of the advantages of the single equation approach is that it avoids the problem of specifying and measuring the links which exist between the monetary and fiscal variables and economic activity. The single equation approach, however, fails to explain anything about the monetary and fiscal policy decisions of the authorities. The fact remains that the independent variables, which are designed to measure the monetary and fiscal influences on the economy, can only be taken as a measure of the policy *intentions* of the authorities if it can be assumed (or proven) that the authorities have acted to control these monetary and fiscal variables. Keran [27, pp. 7-8] discusses this problem in detail and argues that information as to whether the policy makers act to control these variables can only come from the so-called 'reaction functions' of such authorities. This important argument is discussed in detail in Chapter 3.

The suggestion that more realistic and practical results can be obtained from the use of a structural model is supported by Artis and Nobay [11, p. 36] who emphasize that:

> '... it is likely to be difficult to sort out the impact of income on money from the impact of money on income, (or, alternatively, to sort out the dependence of each on some third factor). In principle, a set of relationships is needed to resolve the different effects, and this requires a much more detailed analysis. Detailed econometric work on the financial sector and its relationships with the rest of the economy is still something of a novelty.'

2.3 The structural model approach

The logical consequence of the Artis-Nobay argument is to extend from the limitations of the single equation approach and to attempt an analysis of the monetary-fiscal debate in the context of structural models of the economy.

The number of structural models designed to test the relative effects of monetary and fiscal policy is limited. In order to demonstrate the basic principles, two studies are reviewed: the Moroney-Mason [40] and the Kmenta-Smith [28] studies.

The Moroney-Mason study is basically an attempt to investigate the quarterly impact of monetary and government expenditure policies using a dynamic model of aggregate demand. The authors suggest that their structural approach is an improvement on the F-M and the A-J approaches in at least three ways. Firstly, it is a full theoretical model approach, as compared with the single equation ordinary-least-squares estimates of the earlier studies. Secondly, it treats the money supply as endogenous being influenced, among other things, by the monetary base which is treated as the major instrument of monetary policy. Finally, the model is estimated by three-stage-least squares which the authors suggest is preferable especially within the context of an interdependent system.

Moroney and Mason argue that the F-M approach of treating the money supply as exogenous is objectionable both from theoretical and statistical points of view. From the theoretical point of view it is not accurate to do so, since the money supply contains an endogenous component which is induced by changes in income. Because of this, it cannot be treated as a pure instrument of stabilization policy. Following from this, the regression coefficient of the money supply estimated by ordinary-least-squares is inconsistent.

The Moroney-Mason model consists of 7 equations and two identities and the estimates are based on seasonally adjusted, quarterly data from 1953(3) to 1965(4). The equations and identities contained in the model are

$$Y_t = C_t + I_t + G_t + E_t - O_t \tag{2.17}$$

$$C_t = a_0 + a_1 Y_t^d + a_2 C_{t-1} + a_3 M_t + a_4 M_{t-1} + u_{1t} \tag{2.18}$$

$$I_t = b_0 + b_1 (C_{t-1} - C_{t-2}) + b_2 Y_t + b_3 r_{t-2}^L + b_4 I_{t-1} + u_{2t} \tag{2.19}$$

$$Y_t^d = c_0 Y_t \tag{2.20}$$

$$O_t = d_0 + d_1 Y_t + u_{3t} \tag{2.21}$$

$$r_t^L = e_0 + e_1 r_t^S + e_2 Y_t + u_{4t} \tag{2.22}$$

$$M_t^S = f_0 + f_1 r_t^S + f_2 R_t^d + f_3 B_t + u_{5t} \tag{2.23}$$

$$r_t^S = g_0 + g_1 Y_t + g_2 M_t^D + u_{6t} \tag{2.24}$$

$$M_t = M_t^S = M_t^D \tag{2.25}$$

where Y = Gross National Product

Y^d = disposable income

C = consumption expenditure

I = gross private domestic investment

G = government purchases of goods and services

E = exports

O = imports

M = money stock

r^S = short term interest rate

r^L = long term interest rate

B = monetary base

R^d = rediscount rate.

From these equations, the endogenous variables are Y_t, Y_t^d, C_t, I_t, O_t, M_t^S, M_t^D, r_t^S and r_t^L. The predetermined variables are C_{t-1}, C_{t-2}, M_{t-1}, r_{t-2}^L, G_t, E_t, R_t^d and B_t, with the last four being exogenous.

Before discussing the important features of the money supply equation, reference should be made to the problem of exogeneity in regard to government expenditures. Moroney and Mason treat government expenditures as exogenous in their model since they argue that it is only realistic to treat it as endogenous within the context of an *annual* model. Within an annual model, government expenditure could, 'within the course of one year, be influenced by the pace of economic activity' [40, p. 796]. On the other hand, it is reasonable, according to Moroney and Mason, to suggest that government expenditure is exogenous within the confines of a quarterly model because the so-called 'reaction lag' is much greater than three months.

The authors formulate the money supply equation as a function of two exogenous instruments, the rediscount rate and the monetary base. As well as these they include the short term rate of interest. The authors argue that both these instruments are under the direct control of the Federal Reserve. The monetary base is also a relevant instrument of monetary policy manipulated mainly through open market operations.

Because of its attraction,[9] the authors use three-stage-least-squares to obtain the structural form of the model. At the first stage of the estimation, positive autocorrelation is encountered which necessitates the use of a first order autoregressive scheme for the

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9. According to the authors, the chief merit of the 3-S-L-S method is that it utilizes 'in the estimation process, the sample covariances among structural disturbances' [40, p. 802].

estimation of each equation. The reduced form for GNP is then obtained from the structural estimates, giving the impact multipliers. These impact multipliers measure the immediate, first quarter impact on GNP of a change in the corresponding predetermined variable, with all other predetermined variables held constant. In order to determine the *net* influence of the policy instruments (free from the influence of exogenous variables), Moroney and Mason eliminate all lags from the reduced form to obtain the so-called 'fundamental dynamic equation'. From this equation, the authors obtain the dynamic multipliers for the monetary base and the government expenditure instrument with lags up to twenty quarters. Such dynamic multipliers measure the net change in GNP during a given period which is exclusively attributable to a one unit change in an exogenous variable during a past period.

Moroney and Mason's results show that the monetary base multiplier rises to its peak two quarters after the change, whilst the government expenditure multiplier is greatest in the quarter in which the change is made. The monetary base multiplier then declines in strength and eventually becomes negative after 15 quarters. The government expenditure multiplier follows a similar path, becoming negative after 13 quarters and displaying a damped oscillation towards zero. The change in government expenditure has very little effect beyond the initial period, whereas the monetary base has a much stronger influence during subsequent periods.

Moroney and Mason, in summary, suggest that a large number of questions remain to be answered before a confident conclusion can be reached in regard to the relative efficacy of monetary and fiscal policy. The conclusions reached by Moroney and Mason are subject to the limitations of the estimation process. As the authors themselves point out:

> '... the degree of confidence one attaches to [the conclusions] consequently depends upon one's faith in the robustness of the theoretical and empirical specification of the model. By comparison with the models used by Friedman and Meiselman and by their chief critics, as well as the more recent models employed at the Federal Reserve Bank of St. Louis, the ground for faith seems to be firm.' [40, p. 811]

The Kmenta-Smith study is an attempt to test two propositions concerning monetary and fiscal policy. The first proposition is that both monetary and fiscal policy variables are ineffective because of the lag involved in their impact. The second proposition is that the money supply is a more important determinant of aggregate demand than is autonomous expenditure. This second proposition is simply a re-statement of the original F-M hypothesis, using a structural model rather than a single equation approach.

The Kmenta-Smith model consists of 5 equations and 3 identities, and the estimates are based on seasonally adjusted, deflated quarterly data from 1954(1) to 1963(4). The coefficients of the model are estimated using three-stage-least-squares except for the adaptive expectations coefficient in the consumption function which is estimated by nonlinear two-stage least squares. The equations and identities contained in the model are

$$Y_t = C_t + I_t^d + I_t^r + I_t^i + G_t \tag{2.26}$$

$$S_t = Y_t - I_t^i \tag{2.27}$$

$$L_t = M_t + R_t \tag{2.28}$$

$$C_t = a_0 + a_1 Y_t + a_2(L_t - L_{t-1}) + a_3 C_{t-1} \tag{2.29}$$

$$I_t^d = b_0 + b_1 r_t + b_2(S_{t-1} - S_{t-2}) + b_3 t + b_4 I_{t-1}^d \quad (2.30)$$

$$I_t^r = c_0 + c_1 r_t + c_2(S_{t-1} - S_{t-2}) + c_3 t + c_4 I_{t-1}^r \quad (2.31)$$

$$I_t^i = d_0 + d_1 r_t + d_2(S_{t-1} - S_{t-2}) + d_3 t + d_4 I_{t-1}^i \quad (2.32)$$

$$r_t = e_0 + e_1 Y_t + e_2 M_t + e_3 M_{t-1} \quad (2.33)$$

where Y = gross national product

C = consumption expenditures

I^d = plant and equipment investment

I^r = residential construction

I^i = inventory investment

G = government purchases of goods and services plus net foreign investment

S = final sales of goods and services

t = time in quarters (first quarter of 1954 = 0)

r = yield on all corporate bonds

M = money supply

R = time deposits in commercial banks

L = money supply plus time deposits in commercial banks.

The variables G_t, L_t, M_t, R_t are considered exogenous. In so much as M_t is considered to be exogenous, the yield on corporate bonds (r_t) is chosen as the 'dependent' variable which is influenced by M_t. Kmenta and Smith make no comment on either the treatment of M_t or G_t as exogenous variables.

After computing the structural form of the model, the authors derive the impact multipliers and, in a similar fashion to Moroney and

Mason, compute the 'fundamental dynamic equation'. From this equation, the dynamic multipliers are calculated. The results lead the authors to conclude that a positive change in government spending is stimulatory for the first four quarters and then tends to become mildly depressing. This contrasts with the Moroney-Mason study which suggests that the depressing effects of a change in government spending occur after a lag of 13 quarters. On the other hand, a change in the money supply, although having a smaller initial impact, tends to become mildly depressing after a lag of 18 quarters. This again compares with 15 quarters as recognized by the Moroney-Mason study. Because of the nature of the model, the money supply variable acts to change GNP through the effect of the interest rate on investment demand. Such a link is evident from the use of the money supply as an explanatory variable in the interest rate equation and the use of the interest rate as a determining factor in all the investment equations. In order to test an alternative hypothesis, Kmenta and Smith demonstrate the impact of a change in so-called 'liquid assets' (L_t) which, according to the model, operates to change GNP by increasing consumption via equation (2.29). The effects of a change in this variable are very much weaker than those resulting from a change in the money supply.

In contrast to the Moroney-Mason results, Kmenta and Smith find that the long run multiplier for government expenditure is slightly higher than the long run multiplier for the money variable. Table 2.XIII below sets out the dynamic multipliers, for the time path of GNP for both studies, for government expenditure and the monetary variable. As the table shows, government expenditure in the Moroney-Mason model has its major impact in the quarter in which the change occurs. Beyond

TABLE 2.XIII

Dynamic Multipliers for the Time Path of GNP for G and M Variables

LAG (k)	G^{MM}_{t-k}	G^{KS}_{t-k}	M^{MM}_{t-k}	M^{KS}_{t-k}
0	1.225	1.143	0.586	0.317
1	0.372	0.980	0.968	0.223
2	0.281	0.210	0.156	0.153
3	0.226	0.031	1.983	0.114
4	0.179	-0.015	0.808	0.087
5	0.138	-0.029	0.650	0.068
6	0.104	-0.034	0.511	0.053
7	0.076	-0.035	0.392	0.041
8	0.053	-0.036	0.292	0.032
9	0.035	-0.036	0.211	0.025
10	0.021	-0.035	0.145	0.019
11	0.011	-0.034	0.094	0.014
12	0.003	-0.032	0.055	0.010
13	-0.002	-0.030	0.026	0.007
14	-0.006	-0.028	0.002	0.005
15	-0.008	-0.026	-0.014	0.003
16	-0.009	-0.023	-0.025	0.001
17	-0.009	-0.021	-0.030	0.001
18	-0.009	-0.018	-0.033	-0.001
19	-0.008	-0.016	-0.033	-0.001

that quarter a change in government expenditure exerts only minor influence. The Kmenta-Smith study reveals that government expenditure has its major impact in the first two quarters of the change eventually becoming mildly depressing after 4 quarters.

The monetary variable in the Moroney-Mason model tends to exert a strong influence over a period of 4 to 5 quarters and becomes mildly depressing after 15 quarters. On the other hand, the Kmenta-Smith study shows a much weaker impact for the monetary variable, even though it becomes mildly depressing after 18 quarters.

An examination of the cumulative or long-run mutlipliers is also informative in revealing the differences between the two studies in terms of the impact of the monetary and fiscal variables on GNP. Table 2.XIV below gives the long-run multipliers for the monetary and fiscal variables from these studies. In the case of the Kmenta-Smith results, only the multiplier for the money supply is calculated since the 'liquid assets' multiplier operating through consumption is basically insignificant.

TABLE 2.XIV

Cumulative Multipliers for G and M Variables for Time Path of GNP

After	G^{MM}	G^{KS}	M^{MM}	M^{KS}
0	1.225	1.143	0.586	0.317
1 year	2.104	2.364	3.693	0.807
2 years	2.601	2.251	6.054	1.056
3 years	2.721	2.110	6.696	1.146
4 years	2.708	1.994	6.765	1.171
5 years	2.673	1.916	6.644	1.171

The above tabulation once again highlights the influence that the Moroney-Mason monetary variable has over periods after the initial change. The Moroney-Mason results support the contention that, although government expenditure has a stronger initial impact, the monetary instrument has a stronger overall influence on economic activity. Conversely, the Kmenta-Smith study supports the suggestion that fiscal policy, in the form of a change in government expenditure, has both a greater initial impact and a slightly greater overall influence on the time path of GNP than does the monetary variable operating through both the interest rate and consumption.

The Moroney-Mason study can be considered superior to the Kmenta-Smith model on several counts. Firstly, it defines the supply of money as being endogenous. Secondly, it tests the monetary base as a possible policy instrument, and finally, it contains another possible instrument in the form of the rediscount rate. Once again, however, these two models, which can be taken as representative of the small, structural model approach to studying monetary and fiscal behaviour, fail to tackle the problem raised by the possibility of the monetary policy instrument being endogenously set or manipulated in response to prescribed economic or financial objectives.[10] In this respect then, the structural model approach fails in the same sense as the earlier F-M and A-J approach fail to gain a concensus of opinion on an autonomous or exogneous monetary policy variable. Gramlich [24, pp. 513-15], in his evaluation of the two approaches, alludes to the

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10. It is assumed that within the confines of a quarterly model, the government expenditure variable is always exogenous. Thus, the problem centres solely on the monetary variable.

fact that the structural approach appears superior on one other issue: the structural models' attempt to define the instruments of monetary policy. However, these structural model studies are open to the same criticisms regarding their treatment of the policy instruments. The structural model studies also fail to recognize the fact that the monetary policy variable may not be exogenous. That is, it may be set or manipulated in response to certain economic targets. In other words, the two structural model approaches described above both fail to consider the impact of monetary policy set in a non-random manner as an anti-cyclical stabilization tool. The Kmenta-Smith study fails even to consider the possibility that the money supply (however defined) may not be the appropriate policy instrument but may be more accurately defined as a proximate target.[11] The Moroney-Mason study also contains a weakness in this regard, in that it treats the monetary base as the monetary policy instrument. It is more realistic to argue that open market operations or the rediscount rate (for the United States) are the directly manipulated instruments.

One Australian study which has attempted to utilize the structural model framework to test the effectiveness of monetary and fiscal policy is that of Zerby [47]. Zerby integrates both monetary and real variables into his model, but emphasizes that his experiments relate primarily to monetary policy.

The monetary sector of Zerby's model consists of an equation for interest rates and one for 'liquid assets'. The short-term rate of

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11. A 'proximate target' is a variable which is controlled by a policy instrument in order to influence an ultimate target. For example, open market operations as a policy instrument effect the monetary base (the proximate target) in order to influence inflation or unemployment (ultimate targets).

interest (R2) is expressed as a function of the demand for money (represented by income, YD_t), the supply of money (represented by liquid assets, A_t) and the lagged rate of interest:

$$R2_t = \alpha_1 + \alpha_2 YD_t - \alpha_3 A_t + \alpha_4 R2_{t-1}$$

The liquid asset variable is assumed to be dependent on income, the rate of interest, the previous level of liquid assets and a variable which reflects monetary policy (P_t). In this model Zerby takes the SRD ratio and the cash base (K_t) as potential instruments.

$$A_t = \beta_1 + \beta_2 YD_t - \beta_3 R2_t + \beta_4 P_t + \beta_5 A_{t-1}$$

The Zerby model consists of 11 equations and 4 identities and the estimates are based on annual data for the period 1949-1965, using OLS and two- and three-stage-least-squares. The model takes the following form:

$$CD_t = a_0 + a_1 YN_t + a_2 YF_t + a_3 TP_t + a_4 R2_t + a_5 CD_{t-1} \quad (2.34)$$

$$CN_t = b_0 + b_1 YN_t + b_2 YF_t + b_3 TP_t + b_4 CN_{t-1} \quad (2.35)$$

$$ID_t = c_0 + c_1 YN_t + c_2 R2_t + c_3 YF_t + c_4 ID_{t-1} \quad (2.36)$$

$$IF_t = d_0 + d_1 YC_{t-1} + d_2 R10_t + d_3 TC_{t-1} + d_4 IF_{t-1} \quad (2.37)$$

$$\Delta S_t = e_0 + e_1 R2_t + e_2 B_t + e_3 \Delta S_{t-1} + e_4 \left(\frac{S_{t-1}}{Y_{t-1}}\right) \quad (2.38)$$

$$A_t = f_0 + f_1 YD_t + f_2 R2_t + f_3 K_t + f_4 SRD_{t-1} + f_5 A_{t-1} \quad (2.39)$$

$$M_t = g_0 + g_1 Y_t + g_2 X_{t-1} + g_3 M_{t-1} \quad (2.40)$$

$$R2_t = h_0 + h_1 A_t + h_2 YD_t + h_3 R2_{t-1} \quad (2.41)$$

$$RIO_t = i_0 + i_1 R2_t + i_2 RIO_{t-1} \tag{2.42}$$

$$YC_t = j_0 + j_1 E_t + j_2 YC_{t-1} \tag{2.43}$$

$$YN_t = k_0 + k_1 Y_t + k_2 YN_{t-1} \tag{2.44}$$

$$Y_t = CD_t + CN_t + ID_t + IF_t + \Delta X_t - M_t + X_t + G_t + GEI_t + \Delta NS_t \tag{2.45}$$

$$TP_t = YN_t - YD_t + YF_t \tag{2.46}$$

$$YD_t = YN_t - TP_t + YF_t \tag{2.47}$$

$$E_t = CD_t + CN_t + ID_t + IF_t + X_t + G_t + GEI_t \tag{2.48}$$

where CD_t = consumer durable expenditure

YN_t = non-farm personal income

YF_t = farm income

TP_t = personal income taxes (yield)

$R2_t$ = short-term rate of interest

CN_t = consumer non-durable expenditure

ID_t = investment in private dwellings

IF_t = gross private fixed investment

YC_t = company income

RIO_t = long term rate of interest

TC_t = company tax (yield)

ΔS_t = change in non-farm stocks

S_t = non-farm stocks

ΔNS_t = change in farm stocks

B_t = trading bank advances to business

Y_t = gross national product

M_t = imports

X_t = exports

A_t = liquid assets

YD_t = total personal disposable income

K_t = cash base

SRD_t = statutory reserve deposit ratio

E_t = total domestic expenditures

G_t = government expenditure on goods and services

GEI_t = fixed government enterprise investment

Zerby obtains the reduced form of the set of equations and computes the 'delay' multipliers using the lagged values of the endogenous variables. These multipliers trace out the time path of an exogenous change with all other time paths held constant. Zerby performs 'sensitivity' tests by means of simulated changes in structural coefficients. This method of simulation is different from the usual method where definite values are given to the exogenous variables and are used, along with the disturbance or error term, to generate values of the endogenous variables. On the other hand, Zerby's method consists of changing the estimated coefficient value for various endogenous variables and then computing the time path for the one unit change in the exogenous variable.

From his tests Zerby concludes, among other things, that monetary policy tends to require more 'fine tuning' than fiscal policy. Monetary actions have a tendency, in the model, to be destabilizing and, although this can be minimized by increasing the responsiveness of expenditures to the interest rate, this can only be done at the expense of a reduction in the marginal effectiveness of monetary policy.

Although Zerby provides no figures for the delay multipliers accumulated over each of the 6 periods, it is possible to obtain these by interpretation from his graphs. Only those delay multipliers for the effect of the monetary (SRD decrease) and the fiscal (government expenditure increase) policy variables on GNP are tabulated. The results of the estimation give the following delay multipliers:

TABLE 2.XV

Delay Multipliers for GNP

One Unit Change in:

Lag (k)	$\Delta G_t (\uparrow)$	$\Delta SRD_{t-1} (\downarrow)$
0	2.66	1.40
1	1.40	2.53
2	1.26	3.80
3	1.26	5.26
4	1.55	6.93
5	1.80	8.66
6	2.26	10.93

The initial impact of the change in G is very close to the impact multiplier of 2.47 which is obtained by Kmenta [29] in another Australian model. Kmenta's model, however, does not contain a monetary sector and is not analysed in this section.

Zerby's model contains a monetary sector which is a distinct improvement on the sectors contained in the Moroney-Mason and Kmenta-Smith models. Zerby recognizes the fact that the 'proper' monetary instrument is the SRD ratio. He errs, however, by suggesting that the cash base (K_t) is another potential instrument. The monetary authorities in Australia have a direct influence on the size of the base. This is effected through control of Reserve Bank holdings of Government securities which form one of the sources of the base. However, the proportion of the base made up by the holdings of securities is only small, and is thus insufficient to offset any uncontrolled influences on the base as a whole.

2.1.4 Summary

Attempts to compare the relative strengths of monetary and fiscal policy have generally proceeded in two directions. One of the earliest attempts, epitomizing the direct estimation or 'reduced form' approach is the Friedman-Meiselman study. This was followed up, and significantly improved by, the Andersen-Jordan study several years later. Basically several criticisms and weaknesses are inherent in the F-M approach. The major weaknesses have already been discussed; disagreement over the data period, the possibility of a time trend distorting the results, and the difficulty in defining a truly exogenous expenditure and monetary variable.

The A-J study attempts to remedy these limitations by using post-war quarterly data, estimating using first differences, using 'high employment' fiscal variables and by using both the money supply and the monetary base as monetary variables. However, the literature which follows the publication of this study shows only too clearly that the problems are far from resolved. The A-J study still fails on the test of adequately defining a satisfactory exogenous monetary and fiscal policy variable.

The second approach to comparing the relative strengths of monetary and fiscal policy is through the use of structural models. Two of the attempts which directly attack this problem are the Moroney-Mason study and the Kmenta-Smith study. Both these studies, which are basically similar in their approach, can be regarded as a significant improvement on the simplified reduced form approach. Both however, fail to recognize the possibility of their monetary variables being set endogenously in response to changes in economic conditions. The Australian study by Zerby also fails in this respect. Furthermore the Moroney-Mason and the Kmenta-Smith studies both fail to take account of the fact that the money supply may not be *the* monetary policy variable.

Thus, the discussion of these two differing approaches to the monetary-fiscal debate has opened up two significant problems.

(i) the general problem of endogeneity especially in regard to monetary policy variables;

(ii) the 'instrument-target' problem which deals with the recognition of the fact that variables such as the money supply, or the monetary base may, in fact, not be *the* real instruments of monetary policy.

These two problems are discussed in detail in Chapter 3.

APPENDIX 2A

In the Brunner-Metzler model, the narrowly defined money stock (M) is given as the product of a money multiplier (m) and the monetary base (B):

$$M = mB$$

The money multiplier is defined as:

$$m = \frac{1 + k}{r(1 + t + d) + k}$$

where k = ratio of currency held by the non-bank public to private demand deposits

t = ratio of private time deposits to private demand deposits

d = ratio of Government deposits at commercial banks to private demand deposits

r = ratio of total commercial bank reserves to total bank deposits.

See: Burger, A. 'An Analysis and Development of the Brunner-Metzler Non-Linear Money Supply Hypothesis.' Working Paper No. 7 Federal Reserve Bank of St. Louis. May 1969.

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CHAPTER 3: THE PROBLEM OF ENDOGENEITY

The publication of the Friedman-Meiselman and the Andersen-Jordan studies evokes criticism which applies equally to both studies. The endogeneity problem underlies much of this criticism, but comes to light more clearly in the discussion of the Andersen-Jordan work. This chapter discusses the problem of endogeneity in general and illustrates the erroneous nature of comparing monetary and fiscal policy in a situation where the policy variables are incorrectly treated as exogenous. Much of the work in the area originates from the detailed study by Goldfeld and Blinder [6]. A second section of the chapter investigates previous work in the estimation of 'reaction functions' which are seen to be a natural corollary of the endogeneity problem. Some criticisms of the previous reaction function approach are then analysed especially in regard to the monetary policy variable. In particular, the problem of a correct definition of the monetary policy variable is analysed. Finally, the aspect of instrument 'assignment' is discussed and its link with the endogeneity problem examined.

3.1 The endogeneity problem in the monetary-fiscal studies

De Leeuw and Kalchbrenner [2] put forward the first major criticisms which tend to cast doubt on the reliability of the A-J results. The main criticism is that the A-J model does not employ policy variables which are strictly exogenous. That is, they are not subject to control by the policymakers, and are unresponsive to current endogenous forces. De Leeuw and Kalchbrenner bring the problem clearly into focus by describing the two different ways in which the A-J studies can be viewed.

Firstly, the equations can be seen as attempts to use multiple regression to measure the influence of certain exogenous policy variables on national income. Secondly, they can be viewed as reduced forms of a more complex econometric model. In this type of model, the current endogenous variables are assumed to depend on lagged endogenous and other exogenous variables.

The whole basis of de Leeuw and Kalchbrenner's criticism lies in the different definitions of 'exogenous' used in these two views of the A-J system. In the first instance, the term 'exogenous' refers to variables that can be directly controlled by the policymakers. In the second case, the term 'exogenous' refers to variables which are not affected by current movements in the endogenous variables. Here, the statistical requirement is that the exogenous variables are independent of the disturbance term in the equation. This assumption is crucial since, if the exogenous variable is not independent of the disturbance term, it is impossible to detect the direction of influence or the seriousness of bias in the equation. On the other hand, if the variable does not meet the first requirement, it cannot be considered to be an effective policy instrument.

Although A-J are apparently aware of this problem when they define their policy variables, they do not, according to de Leeuw and Kalchbrenner, go far enough in removing the influence of current movements in economic activity from these variables. Generally however, the use of the reduced form approach of A-J and F-M makes it very difficult to devise variables that meet the two exogeneity requirements. This stems from the fact that firstly, the policy variables are influenced by economic developments, and secondly, policy makers are influenced by current economic developments in their decisions. In other words the notion of exogeneity in policy variables on the one hand, and the existence of deliberate stabilization policy on the other, is completely contradictory.

The problem of endogeneity in the A-J study, and in other reduced form studies in general, is discussed widely by many critics. Keran [15] emphasizes that the single equation approach makes no mention of the monetary and fiscal policy decisions of the relevant authorities. Keran argues that the relevant policy variables only represent a measure of the actual policy intentions of the authorities if it can be shown that the policy makers act consciously to systematically control them. Keran stresses that this type of evidence can only come from studies of the so-called 'reaction functions' of the policy makers, in which a relationship is established between the policy instruments and the independent target variables.

The idea that policy instruments used in either reduced form studies, or even in structural model studies, can be endogenous has been put forward by other critics as well. Karaken and Solow [14] in their study of monetary policy lags make the point that a perfectly successful monetary policy, as far as forecasting and stabilization is concerned, shows a zero correlation between monetary change and the level of economic activity. Similar conclusions are also suggested by Rhomberg [24] and Shapiro [25] and the general problem of correlation between targets and instruments is discussed by Prest [22], Worswick [28] and Peston [21].

Gramlich [7], in a study which concentrates on the relative impact of monetary and fiscal policy, suggests the inclusion of policy instruments in the welfare function of the stabilization authorities. He also highlights the question of whether or not the actions of the monetary authority are entirely exogenous. Gramlich suggests that the problem of the endogeneity of stabilization authorities is not important if their actions 'do not respond immediately to stabilization needs' [7, p. 52]. This latter point means, in effect, that the problem of endogeneity of policy actions is not important if the response of the authorities to the endogenous forces in the economy occur with a lag. That is, if they occur in a period other than the current quarter.

The same point is made by Rhomberg [24] in comments on Gramlich's paper. Rhomberg suggests that one of the difficulties involved in estimating the impacts of monetary and fiscal policy on economic activity is the fact that instruments of stabilization policy cannot be regarded as exogenous (or predetermined) in the exogenous sense, '... because if they really were exogenous, they would not be conducive to stabilization' [24, p. 548].

Rhomberg suggests that it is not possible to accurately test the relative impacts of monetary and fiscal policy as long as monetary policy is used more actively for stabilization purposes than fiscal policy. This conclusion follows because, if a stabilization authority is able to forecast accurately, and stabilize income perfectly, any reduced form regression which uses a monetary policy variable as a determinant of GNP yields an insignificant regression coefficient for that policy variable. The same idea is also stressed by Shapiro [25] who suggests that where the monetary authorities are able to perfectly forecast future events, a reduced form regression analysis of the monetary variable on GNP would show up large variations in the monetary variable with no movements in GNP.

One of the first major attempts to investigate the implications of the endogeneity-exogeneity problem is contained in an article by Goldfeld and Blinder [6]. In this study, the authors discuss the problems encountered in econometric studies when the policy variables treated as exogenous are, in fact, endogenous. A simple illustration of these problems is presented with the aid of a representative structural model in which there are control instruments for each of the two stabilization authorities. National income is assumed to be determined by a single stochastic relationship relating consumption (C) to income (Y) with a stochastic element (μ).

$$C_t = a + bY_t + \mu_t \tag{3.1}$$

The equilibrium condition is:

$$Y_t = C_t + I_t + G_t \tag{3.2}$$

where I = investment demands

and G = government demands.

The G_t element is assumed to be controlled by the fiscal authority and the I_t element is controlled by the monetary authority. Goldfeld and Blinder suggest that problems will arise if the policy instruments, even though exogenous in the economic sense, are related to some endogenous variables in the model.

For example, A-J, in their monetary-fiscal study, make use of the reduced form to estimate the relevant policy multipliers by ordinary-least-squares. That is, the reduced form given by the following:

$$Y_t = \frac{a}{1 - b} + \frac{G_t}{1 - b} + \frac{I_t}{1 - b} + \frac{\mu_t}{1 - b} \tag{3.3}$$

In the Goldfeld-Blinder example this expression is estimated by ordinary-least-squares, and the estimated coefficients of G_t and I_t are taken as the fiscal and monetary multipliers, respectively. This method produces satisfactory results only as long as the policy variables are known to be exogenous in the statistical sense. If policy is formulated endogenously then G_t and I_t may be correlated with the disturbance term, μ. Thus, the whole thrust of Goldfeld and Blinder's argument is that equation (3.3) is not a true reduced form equation, and a specification error is introduced by treating G_t and I_t as exogenous when they are, in fact, endogenous.

Goldfeld and Blinder also argue that the interpretation of the reduced form coefficients as policy multipliers in (3.3) is extremely misleading, unless the policy variables are endogenous. They maintain that, if endogenous policy is treated as exogenous the effective use of stabilization policy will result in a small and statistically *insignificant* multiplier. On the other hand, ineffective use of stabilization policy will result in a large and statistically *significant* multiplier.

This aspect of the problem is illustrated by Goldfeld and Blinder with the use of two hypothetical 'reaction functions' which assume that the policy makers are reaching endogenously to economic conditions. Even if the estimation biases are negligible, thus making the estimated coefficients a and b in equation (3.1) reasonably accurate, the continued ignorance of these policy reaction functions results in biased estimates of the policy multipliers.

Suppose, for example, that the policy authorities are reacting endogenously to economic conditions, then they may have a long run desired path for their policy instruments which can be formalized as follows:

$$G_t = G_t^* - g(Y_t - Y_t^*) + v_t \tag{3.4}$$

$$I_t = I_t^* - m(Y_t - Y_t^*) + e_t \tag{3.5}$$

In this example, G_t^*, I_t^* and Y_t^* are the target values of the variables, and g and m are the reaction coefficients.

If the reaction functions are ignored, then the normal policy multiplier obtained from (3.1) and (3.2) is as follows:

$$\frac{dY}{dG} = \frac{1}{1 - b} \quad \text{and} \quad \frac{dY}{dI} = \frac{1}{1 - b} \tag{3.6}$$

On the other hand, acknowledgement of the existence of reaction functions results in policy multipliers (by computation from equations (3.1), (3.2), (3.4) and (3.5)) of the form:

$$\frac{dY}{dG^*} = \frac{1}{1 - b + g + m} \quad \text{and} \quad \frac{dY}{dI^*} = \frac{1}{1 - b + g + m} \tag{3.7}$$

Goldfeld and Blinder suggest that the multiplier bias is more likely to occur in the estimation of monetary policy multipliers. In the monetary area, the decision period for stabilization policy is often shorter than the quarterly data period most often used in econometric models. In these types of models, the effect of the decision period being shorter than the data period is to hold the policy instrument constant throughout the quarter. Goldfeld and Blinder maintain that there is no reason, in practice, for an authority to be bound, for the entire quarter, by any initial decision. Their basic contention is that the continual revision of data needed for forecasting purposes emphasizes the need for a prompt adjustment of initial forecasts, and consequently, for prompt alteration of policy instruments.

The constant revision of the stabilization tools, due to alterations to initial forecasts, has the effect of imparting contemporaneous correlation between the policy variables and the disturbance terms. Equations (3.4) and (3.5) above are specific examples of how the policy instruments, G_t and I_t, used in Goldfeld and Blinder's model, can become negatively correlated with the disturbance term of the partial reduced form. However, if the policy makers react only with a lag and there is no autocorrelation in the disturbance term, the multipliers calculated from such a system will be unbiased. If there is autocorrelation present the bias will persist. That is, lags which may occur in the reaction of the authorities to current endogenous forces will tend to eliminate any simultaneous equation bias if the disturbance term is independent over time, and not serially correlated.

The study by Goldfeld and Blinder stresses the necessity for deriving estimates of monetary and fiscal policy multipliers from a structural model in preference to the A-J reduced form approach. They also concede that even the structural model view does not resolve the endogeneity problem discussed above. The problem can be resolved only by combining a structural model approach with reaction functions describing the manipulation of policy instruments in response to movements in various targets of economic policy. In line with this view, Goldfeld and Blinder estimate the Moroney-Mason model of the United States economy [18], and include hypothetically estimated reaction functions. These functions relate the two stabilization instruments, given as unborrowed reserves plus currency, and government purchases, contemporaneously to growth, interest rate and external balance targets. These functions are hypothetically estimated, by setting their parameters to correspond with a less active fiscal policy.[1] Goldfeld and Blinder are able to conclude that the incorrect treatment of policy instruments as exogenous has no significant effect on the estimates of the structural equations. Rather, the authors show that the benefit of including the reaction functions in the simple model becomes apparent in the calculation of the fiscal and monetary multipliers. They find that the policy multipliers obtained from the model which ignores the endogeneity problem differ substantially from those obtained from the model augmented by the reaction equations.

The above discussion and summary of the endogeneity problem establishes the fact that it is important to attempt to determine the nature of reaction functions. This follows from the conclusion that serious bias results in the comparison of the relative strengths of monetary and fiscal policy in those cases where an endogenously determined policy instrument is incorrectly treated as exogenous. The following section will focus on a number of previous attempts to estimate reaction functions for the monetary sector. From this review of the literature it is hoped to pinpoint the weaknesses and pitfalls of the various approaches, especially in relation to the problem of adequately choosing the appropriate instrument.

3.2 A survey of previous reaction function studies

One of the earliest studies attempted in this area is one by Dewald and Johnson [3] who argue that the monetary authorities have certain economic policy objectives in mind in all their monetary policy changes. The authors perform statistical regressions using quarterly

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1. In later tests, the authors altered the coefficients of the functions to correspond to alternative monetary and fiscal policies.

data for the period 1952(1) to 1961(4). The objectives or targets are defined as price stability, high employment, a satisfactory balance of payments and economic growth. For these targets the authors use the Consumer Price Index (P_t), the unemployment percentage (U_t), the balance of payments deficit (B_t) and real gross national product (Y_t). Taking the reaction function with the money supply (M_t) as the dependent variable, the following equation is tested:

$$M_t = a_0 + a_1 M_{t-1} + a_2 U_t + a_3 Y_t + a_4 P_t + a_5 B_t \qquad (3.8)$$

Dewald and Johnson emphasize that the use of the money supply as the policy instrument or indicator 'does not necessarily establish the money supply as the control variable actually used by the monetary authorities' [3, p. 174].

Only the first three independent variables prove to be statistically significant in the estimation. Dewald and Johnson make use of their estimated function to analyse the 'tradeoff' between the independent variables and the money supply. Also, they investigate the distributed lag reaction structure by assuming that the money supply indicator is subject to an exponentially diminishing distributed lag. The more important result of this test is that the weighted average lag in reaction is found to be more than three quarters. According to the authors, this finding raises important questions concerning the flexibility of monetary policy.

The authors also experiment with various indicators of money market conditions, namely the Treasury bill rate, the Treasury long term bond rate, and free bank reserves. The latter indicator is insignificant, but significant results are obtained with the first two. In general, however, the authors conclude that only the unemployment and the growth targets remain consistently significant as economic targets with all the postulated policy indicators. Also, from their experiments with the distributed lag technique, they argue that the monetary authorities appear to react more quickly to the economic targets if they aim to control money market conditions rather than the quantity of money.

Although not producing any new ideas in regard to the estimation of a reaction function, Christian [1] emphasizes two important faults of the Dewald-Johnson analysis. Firstly, no attempt is made to report on the stability of the regression coefficients for the purposes of determining whether or not a temporally consistent policy making framework exists.[2] The consequence of this instability is that the coefficient of the lagged dependent variable is unstable over time, making the distributed lag formulation, used by Dewald and Johnson, unreliable for estimating the lagged response. The second major criticism suggested by Christian is the impossibility of disentangling the combined influence of *weight* and *effect* from the regression coefficients obtained in a reaction function estimation. In this regard, Christian queries the desirability of assuming that policy objectives can be treated as independent of one another.

To measure the stability or instability of the reaction functions, Christian makes use of 'moving regressions' of 20 observations each for the period 1952(1) to 1966(4). The use of these moving regressions helps

2. Christian argues that a 'temporally consistent policy making framework' simply means that the relative weights attached to each coefficient do not change over time. According to Christian, the single period estimation used by Dewald and Johnson gives no idea of how these relative weights change over time.

to eliminate the arbitrary selection of initial and terminating dates. His major contention, in using this approach, is that if the coefficients are shown to be unstable, the monetary authority is unlikely to have any consistent set of decision rules for the achievement of different objectives. Christian also defines 'periods of concern' for particular economic targets. By taking moving averages of the values of each of the targets, Christian denotes 'periods of concern' as those which show a relatively large change in the value of the moving average from period to period. He argues that large regression coefficients for each of the targets should be associated with the 'periods of concern' for those particular targets.

Christian uses the same four policy targets as used by Dewald and Johnson. He also experiments with one other derived from taking the difference between desired and actual income. In general, he finds that a reasonably consistent policy formulation framework does exist. Thus, the periods of concern for each of the economic targets are closely associated with large regression coefficients for these targets. However, there is a certain degree of inconsistency with respect to the price stability and balance of payments objectives which, Christian suggests, can be either due to a non-linear response or, to the fact that the response to inflation is dependent on the achievement of the full employment objectives. He also finds a general instability in the coefficient of the lagged dependent variable. This suggests that the distributed lag formulation, as used by Dewald and Johnson, is unreliable.

Using an analysis similar to Dewald and Johnson, both Reuber [23] and Havrilesky [8] run multiple regressions of certain indicators of monetary policy on various economic targets. Havrilesky makes use of one indicator, defined as total reserves adjusted for legal reserve requirement changes, whilst Reuber tests the money supply, cash reserves and the Treasury Bill rate. Reuber's study uses similar targets to the Dewald-Johnson study; full employment, price stability and economic growth. Havrilesky also uses these targets and, in addition, uses an external target. Havrilesky's reaction function takes the following form:

$$R_t = a_0 + a_1Y_t + a_2U_t + a_3(P - P')^2 + a_4i_{f_t} + a_5B_t \qquad (3.9)$$

where Y = gross national product

U = percentage unemployment

P = Wholesale Price Index, base 1958 = 100

P' = Wholesale Price Index goal, bases 1952-57 = 92; 1958-65 = 100

B = balance of payments deficit or surplus

i_f = average of several overseas long term government bond yields.

The response of the policy indicator, to changes in the economic targets, is linear in all cases except for price inflation. Because of the uneven increase in this target during the period analysed, Havrilesky assumes two price level targets. He also introduces these into the equation in squared form. The purpose of this is to effect policy reactions to increases in the price level above these two target levels. According to Havrilesky's results the monetary policy indicator responds to all the specified targets except for the balance of payments.

Reuber's study, although adhering to the three main targets of price stability, growth and unemployment, experiments with several variations. For instance, he tests the reciprocal and the square of the unemployment percentage, a productivity index as a proxy for growth and various logarithmic forms of the equation. After several experiments Reuber dismisses cash reserves and the Treasury bill rate as potential indicators, and selects the money supply, both real and nominal, as the best performed. The eventual form of his function is as follows:

$$\log M_t = a_0 + a_1 U_t^{-1} + a_2 \log \theta_t + a_3 \log P_t + a_4 \log M_{t-1} + a_5 \log M_{t-2} \qquad (3.10)$$

where M = money supply

U^{-1} = unemployment percentage

θ = productivity index

P = consumer price index.

Reuber finds similar results to Havrilesky but also notes an oscillatory reaction pattern probably implying that the authorities react to changes in the economy by a process of 'successive approximation'. Here they observe errors in the performance of the economy, such as increasing unemployment or declining income, and they react accordingly.

One of the first signs of increasing sophistication in the study of reaction functions is evident in the work done by Wood [27]. His study advances the argument a stage further and postulates more realistic monetary policy instruments. Instead of assuming that the monetary authority actually uses the money supply or bank reserves as the policy instrument, Wood is more realistic. He postulates that the Federal Reserve manages its portfolio of government securities in order to maximize utility, subject to the constraints imposed by the economy.[3]

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3. Wood's mathematical derivation of the form of reaction equations is set out in Appendix 4A at the end of Chapter 4.

Consequently, his work criticizes the approach of Dewald and Johnson. He maintains that their study falls short of an analysis of Federal Reserve behaviour in that they treat the so-called 'intermediate financial variables' as policy instruments. Wood argues that the Dewald-Johnson approach[4] can only cast light on Federal Reserve behaviour if the intermediate financial variables are completely controlled by the monetary authorities, and are actually manipulated as policy instruments.

A somewhat different approach is used by Keran and Babb [16] who link the monetary base to a free reserves target, an 'even keel' target (the change in the national debt held outside Federal Government trust accounts), and an interest rate stability target. The free reserves target is used as a proxy for the usual economic targets used in the previous reaction function studies. The authors put forward the argument that it is possible to relate changes in the level of free reserves with the directives of the Federal Open Market Committee. These are aimed at the maintenance of full employment, price stability, growth and external balance. Keran and Babb prefer changes in the cash base of the economy to open market operations as the major monetary policy instrument. The cash base is not used to smooth out any fluctuations in the level of free bank reserves.

Keran and Babb argue that the use of the cash base is justified by the drawbacks inherent in previous studies which relate objectives or targets to instruments. The major drawback is that the policy objectives may not be independent of each other. Secondly, the preferences of the policy maker, with respect to achieving desired levels of alternate

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4. And, by implication, the other studies by Reuber, Havrilesky etc. which use intermediate variables as instruments.

targets, may be interdependent. Finally, the observed values of the target variables may differ very little during the period being studied, thus making difficult any attempt to quantify the link between actual and desired levels of the targets. In general, Keran and Babb conclude that the behaviour of the monetary authority is consistent over the period studied with the various stabilization objectives. They find that the Federal Reserve tends to concentrate on 'even-keel' and financial objectives, which may interfere with economic stabilization objectives.

Further work is also carried out in this area by Lombra and Torto [17] who attempt to test the basic hypothesis that 'the majority of open market operations can be explained by the systematic response of the Federal Reserve to changes in economic activity' [17, p. 50]. The authors conclude that the monetary authorities use open market operations as a 'defensive' instrument to offset changes in the monetary base and to accommodate changes in the demand for deposits and currency.

The work of both Fisher [4] and Nobay [20] is concerned with a direct estimate of reaction functions for several instruments of British monetary policy; the Bank rate, Special Deposits, hire purchase controls, the liquid-assets ratio, the Treasury Bill rate, the 2½ per cent Consul, the Bank of England portfolio of Government securities, and a quantitative instrument, the Advances Ceiling. Fisher concentrates primarily on the first three of these monetary instruments as the more important and attempts to relate each to three target variables; the level of gold reserves, the price level and the rate of unemployment.[5]

5. Fisher finds the growth variable to be insignificant as a monetary target.

Generally, he is able to find a significant reaction to all three targets.

Nobay's work is of more interest because he experiments with a fiscal policy surrogate[6] and also allows for possible interdependencies between the monetary policy instruments. For this purpose, he experiments with the inclusion of monetary policy instruments as dependent variables in other monetary reaction functions. This approach was originally used by Dewald and Johnson who included the money supply 'instrument' in their reaction function for free bank reserves. Nobay also includes other financial objectives along with the usual economic stabilization targets.

Nobay's paper differs somewhat from previous reaction function studies because of his above-mentioned experiments. He finds, for example, that the inclusion of the fiscal surrogate (in the form of a measure of the cumulative impact of the 'first-round' effects on GNP of defined taxation changes) substantially improves the estimated relationships. Also, the simultaneous introduction of the other policy instruments, in the reaction function, leads to satisfactory results. This finding is backed up by the fact that the results obtained using either two-stage-least-squares or the full-information-maximum-likelihood method differ considerably from those obtained using ordinary-least-squares.

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6. Several attempts at derivation of appropriate fiscal indicators were carried out in the United States in the original work on the Andersen-Jordan approach. These usually took the form of 'initial stimulus' or 'full employment' measures. The surrogate used here by Nobay has been derived from work done by Hopkin and Godley [10].

Nobay's findings support the ideas that variables conventionally assumed to be 'instruments' of monetary policy have not always been treated as such by the monetary authorities. His findings also highlight the possible need to consider the general interaction of monetary policy setting, not only in regard to the simultaneous setting of monetary instruments themselves, but also the possibility of an interaction between monetary and fiscal policy. One further aspect which is brought up in Nobay's discussion is the contention that monetary policy concerns itself primarily with the maintenance of external equilibria. Several overseas financial objectives, such as overseas interest rates, the forward discount rate on sterling, and ratios of overseas to domestic interest rates, all clearly have a role to play in determining the behaviour of the monetary authorities.

Later American studies increase the degree of sophistication of reaction function estimation, and at least one attempts to experiment with lag techniques other than the simple distributed lag technique of the earlier approaches.[7] Froyen [5], in his analysis of monetary policy reaction functions, uses the monetary base and experiments with monthly data and the Almon lag technique. This study is one of the first to explicitly use the work of Goldfeld and Blinder as a background for reaction function estimation. Froyen emphasizes the importance of determining current period reactions between policy instruments and

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7. For example, both Dewald and Johnson and Fisher experimented with the inclusion of a lagged dependent variable in order to determine the average weighted lag of the reaction of the instrument to the economic targets. The expression for the weighted average lag is $L_i = b_i/1 - b_i$ where b_i is the coefficient of the lagged dependent variable. The distributed lag itself is computed from the expression $T_0 = 1 - b$; $T_1 = 1 - b^2$ etc. where T is the proportion of the total effect realized by the end of each time period.

targets. However, the use of monthly data enables him to experiment with lags of up to three periods whilst still demonstrating the presence of contemporaneous influences in terms of quarterly data.

The use of Almon lags also serves to increase the scope of the study, although a major flaw in Froyen's study is his assumption that the lag between each of the targets and the cash base is identical. Froyen also defines desired unemployment, a desired rate of inflation and a desired balance of payments target in his study. In the course of his analysis, the desired inflation rate of 2 per cent is altered and both higher and lower rates are tested. Froyen reports that these adjustments fail to improve his results. A closer examination of Froyen's estimation technique however, reveals that the use of 'desired' targets has no influence on the outcome of his results since they are merely equivalent to the subtraction of a constant term from the target itself. Froyen's reaction function takes the following form:

$$\begin{aligned} M_t = {} & a_0 + \sum_{i=1}^{n} a_1(U - U^*)_{t-i} + \sum_{i=1}^{n} a_2(P - P^*)_{t-i} \\ & + \sum_{i=1}^{n} a_3(B - B^*)_{t-i} + \sum_{i=1}^{n} a_4 Y_{t-i} + a_5 D_{t-1} \\ & + a_6 \Delta r_{t-1} + a_7 FS_{t-1} \end{aligned} \tag{3.11}$$

where M = the monetary base (the adjusted monetary base, equal to unborrowed reserves plus currency is also tested)

U = the percentage unemployed

P = the consumer price index (1958 = 100)

B = balance of payments surplus

Y = total manufacturing and trade sales

D = outstanding privately held federal Government debt.

r = long term corporate bond rate

FS = full employment surplus.

The first four variables defined above are designed to represent macro-economic stabilization targets. The next two (D and r) represent the influence of independent financial objectives of the monetary authorities on monetary policy. Such an approach stems from the findings of Keran and Babb [16] who suggest that macroeconomic stabilization goals are not always important and, that other independent financial objectives dominate Federal Reserve policy.

In each of three separate subperiods studied (1953-60, 1961-68, and 1969-72) the stabilization targets are found to have some influence, in varying degrees and combinations, on monetary policy. Froyen is able to conclude that in the case of single equation reduced form models the monetary base cannot be assumed exogenous. All estimates of policy multipliers, based on the coefficients of such a model, are therefore biased.

The approach adopted by Hosek [11] assumes that the Federal Reserve attempts to control four monetary aggregates; the money supply, total member bank reserves, member bank free reserves and bank credit. These are assumed to influence ultimate economic targets such as unemployment and inflation. Instead of treating the monetary aggregates as instruments, Hosek assumes them to be intermediate targets which can be controlled by the Federal Reserve through the use of open market operations.[8]

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8. This is the approach adopted by Wood, although that author fails to explicitly bring in the idea of an intermediate target. The study by Nobay [20] serves to place emphasis on this aspect of the monetary authority controlling ultimate targets by the influence of intermediate variables on these ultimate targets. However, even his approach falls slightly short of Hosek's method of analysis.

Each of Hosek's reaction function models contains three equations; a desired target function, an actual target function and an equilibrium condition. The desired target function relates the intermediate target to the ultimate targets of policy. Hosek defines the desired target in terms of the ultimate targets. He then defines the actual level of the target, equates the two and is able to derive a reaction function for the open market instrument. This function is now in terms of the ultimate targets and the various components of the monetary base which need to be offset in order to achieve these targets. For example, if it is assumed that the monetary authorities desire to control the money supply in response to certain economic targets (taken as unemployment (U) and inflation (P)),[9] the desired money supply (M) function is as follows:

$$M_t^* = a_0 + a_1 U_t + a_2 P_t \tag{3.12}$$

Hosek then assumes that the monetary authorities respond to a weighted average of current and past values of the target variables. With geometrically declining weights, the desired money supply function becomes:

$$M_t^* = a_0 + a_1 \sum_{i=0}^{\infty} r^i U_{t-i} + a_2 \sum_{i=0}^{\infty} r^i P_{t-i} \tag{3.13}$$

9. Hosek uses only inflation and unemployment targets for two reasons. Firstly, previous studies have failed to produce any significant results for the external target and, secondly, the objectives of growth and unemployment are not independent of one another. Higher levels of growth, for example, are associated with higher employment.

This can be written as:

$$M_t^* = (1 - r)a_0 + a_1U_t + a_2P_t + rM_{t-1}^* \qquad (3.14)$$

The actual target function defines the money supply as the product of base money (B) and the money multiplier (m):

$$M = mB \qquad (3.15)$$

Total base money can be split into holdings of Government Securities (S) and the total of all other components (B_0). Hence:

$$M = mB_0 + mS \qquad (3.16)$$

Assuming that the monetary authorities act in order to equate the actual level of M with the target level, the following reaction function is formed:

$$S = (1 - r)a_0 \frac{1}{m} + a_1 \frac{U}{m} + a_2 \frac{P}{m} + r \frac{M_{t-1}}{m} - B_0 \qquad (3.17)$$

The same method is used by Hosek to obtain reaction functions for total reserves, free reserves and bank credit in terms of open market operations. Using quarterly data from 1952(1) to 1971(4) the equations are estimated using the ordinary-least-squares method. In most cases the coefficients of the inflation and unemployment targets are of the correct sign, although the statistical significance varies somewhat. Hosek also splits his test period and detects instability in all but one of the functions.

One of the first Australian monetary policy reaction studies is that of Jonson [12]. This study is part of an overall reaction function analysis for both monetary and fiscal policy instruments. The targets chosen by Jonson are designed to reflect the state of the labour market, the price level and the external position. These targets are represented respectively, by the ratio of registered job vacancies to registered unemployment, the consumer price index and the level of foreign reserves. Apart from the two monetary instruments, the SRD ratio (SRD) and 'the' bond rate (RGM), Jonson also tests several fiscal instruments including a set of tax rates and Commonwealth non-defence expenditure. Stability tests, as stressed by Christian, are carried out by splitting the total sample period into two subperiods, 1959-1965 and 1966-1971.

The function for the interest rate (RGM) equation requires modification to allow for the fact that lagged changes in the stock of money (M) might influence interest rate policy. This will occur if the money stock is growing either too rapidly or too slowly. Thus, a desired relationship for the interest rate is specified which postulates that an increase in interest rates occurs if the money stock grows too rapidly. This relationship is of the form:

$$RGM_t^* = a_0 + a_1 \Delta \dot{M}_{t-1} \qquad (3.18)$$

where $a_1 > 0$.

From the estimated equation Jonson concludes that there is, in fact, some evidence that the rate of growth of the money stock influences interest rate policy.

The SRD equation also requires some degree of modification because of two influences. Firstly, the ratio has a declining trend during the period studied, and secondly, Jonson maintains that the ratio is set so as to offset the influence of variations in foreign reserves (FR) on bank liquidity. This relationship is of the form:

$$SRD_t = a_0 + a_1 T_t + a_2 FR_t \tag{3.19}$$

where T = time trend.

Jonson is able to conclude that there is some evidence of a systematic manipulation of the policy instruments in accord with movements in the target variables. In the first subperiod studied, Jonson's results tend to support the view that fiscal policy is a more effective domestic policy weapon, and monetary policy is more effective in countering external imbalances. For example, the interest rate instrument, as used by Jonson, has a greater influence on external balance. On the other hand, fiscal variables, in the form of government expenditure, are more conducive to controlling prices. In the second subperiod however, the issue becomes less clear and the assignment of various instruments to specific areas of policy, almost non-existent.

3.3 Criticisms of previous reaction function studies

Despite the progress made towards developing a satisfactory approach to the formulation and estimation of reaction functions, at least two problems still exist. Firstly, there is the problem of choosing a suitable monetary policy instrument. This inadequacy, on the part of nearly all previous reaction function studies, becomes of great importance when considered in the light of Waud's [26] arguments. Secondly, there is the obvious failure of previous studies to investigate the assignment of monetary instruments between external and internal policy. Both these difficulties are discussed in the following sections.

3.3.1 Selection of an appropriate instrument

The early reaction function studies of Dewald and Johnson, Reuber, Havrilesky and Fisher all make use of *indicators* such as the money supply for the monetary policy instrument. Dewald and Johnson recognize that the use of the money stock may be misleading and they subsequently proceed to estimate reaction functions for various indicators of money market *conditions* rather than money market *quantities*. However, the use of money market variables (such as interest rates) implicitly presupposes that these are *the* instruments of policy.

The work of Nobay marks a basic change in this approach and, in the discussion leading up to his particular study, he examines the problem of selection of an appropriate monetary policy instrument [20, pp. 294-6]. In examining the traditional framework behind the behaviour of the monetary authorities, Nobay stresses that it is important to distinguish between the *instruments* of the monetary authorities, the *intermediate targets* and the *ultimate targets* which the monetary authorities attempt to influence. The variables treated as instruments must be completely under the control of the monetary authorities. They must also be capable of eventually influencing the ultimate targets, either directly or indirectly, by way of the intermediate financial targets. In this analysis, Nobay emphasizes the need to avoid confusing the instrument variables with the intermediate variables. He defines these intermediate variables as either interest rates or various financial quantities such as the money supply.

A major article by Waud [26] concentrates solely on the problem of defining appropriate and accurate instruments, intermediate targets and ultimate targets. In this article, Waud is critical of the approach of previous papers which assume that (i) the monetary authorities treat variables such as the money supply and interest rates as policy instruments, and (ii) that there exists a perfectly unambiguous relationship between the money supply (or the interest rate) and the ultimate targets of policy. Waud argues against the assumption that the money supply or the interest rate are instruments of policy because they are not completely controlled by the monetary authorities. Waud maintains instead, that other variables, such as open market operations and reserve requirement changes are the true instruments of policy. He classifies variables such as the money supply and the interest rate as *intermediate* or *proximate* targets. These are influenced by the true instruments of policy. The intermediate or proximate targets, in turn, affect the ultimate targets of policy.

After an extensive mathematical exposition Waud concludes that the monetary authority cannot assume that a proximate or intermediate target is a good substitute for an ultimate target. He maintains that the monetary authority is better advised to focus on ultimate targets because of the unambiguous relationship between the intermediate targets and the ultimate targets.

This criticism tends to show up a basic weakness in previous reaction function studies. The majority of these studies formulate their reaction functions in terms of a relationship between the intermediate target and the ultimate targets of policy. In doing so, they make two incorrect assumptions. Firstly, they postulate that an unambiguous relationship exists between the intermediate and the ultimate targets. Secondly, they suggest that intermediate targets can be correctly used as instruments of policy.

In an Australian context, the identification of the policy instruments and their relationship to the intermediate targets is again ambiguous. The *credit rationing* instrument is clearly the SRD ratio, but the identification of the *market* instrument is a contentious issue. There are two views at the official level which may be summarized in the argument about *rates* and *quantities*. The first view argues that the instrument is the set of administered rates of interest and that an active interest rate policy envisages a flexible attitude to these administered rates. Such a view also assumes that administered rates influence market rates. An active interest rate policy will need to be reinforced by open market operations. The alternative 'quantities' view treats open market operations as the instrument of policy. This instrument is reinforced by required interest rate changes. In brief, the 'rates' approach treats 'the' interest rate as the policy instrument. The Reserve Bank's holdings of securities are adjusted to suit the policy. The 'quantities' view treats the Reserve Bank's securities stock (S) as the instrument, with the interest rate being adjusted to make open market operations workable.

3.3.2 Assignment of monetary instruments

One further drawback of the previous reaction function studies is their obvious failure to concentrate any attention on the *assignment of monetary instruments*. Mundell's [19] original interpretation of the assignment problem suggested that, in an economy with a fixed exchange rate, monetary and fiscal policy instruments could be assigned to external and internal stabilization respectively. The approach adopted in this thesis differs from that taken by Mundell. Here, emphasis is given to the problem of assignment of monetary instruments *between* internal and external stabilization targets. Thus, it is a simple extension of the Mundell argument which considers monetary policy unsuitable for internal policy stablization.

One of the major reasons for the failure of previous reaction function studies to analyse the assignment problem *within* monetary policy is the fact that these studies fail to differentiate between intermediate targets and instruments. If the correct instruments had been used then some conclusion could have been reached as to their relative importance in dealing with external or internal policy stabilization. Instead, however, the tendency to experiment with variables which are more correctly defined as intermediate or proximate targets means that the relative influence of the true instruments on external and internal stabilization is concealed. For example, by incorrectly using intermediate targets as instruments, one may come to the conclusion that the rate of interest or the money supply is strongly associated with movements in external targets. However, the rate of interest and the money supply are only intermediate targets which can be influenced by more than one monetary instrument. Thus, no accurate conclusion can be reached as to *which* monetary instrument is reacting to external disequilibria. Instead, all that can be said is that the money supply or the interest rate changes in order to offset or correct external disequilibrium. However, either of two or three monetary instruments could have reacted to alter the original external imbalance. The same argument can be used in regard to the internal targets, price stability and full employment.

One further important fact also adds to the inability of the previous reaction function studies to detect an assignment of monetary policy instruments: the unambiguous nature of the relationship between the intermediate targets and the ultimate targets. Whereas the early studies may not have found any reaction of their chosen monetary instruments to external targets, this may have been entirely due to a weak and statistically insignificant relationship between these monetary targets and the external targets. Combining this with the fact that the majority of these early studies actually use incorrect monetary policy instruments, one can see why unsatisfactory results are often obtained for a response to external targets, and why there has been no adequate discussion or analysis of the assignment problem between various monetary instruments.

Studies such as those of Dewald and Johnson and Havrilesky all fail to find a significant relationship between the chosen monetary instrument and the external target. In addition, the Dewald-Johnson study failed to find any significant relationship between the price stability target and any of the money market rates or quantities tested. As has been emphasized, these findings may be the result of a combination of the above mentioned weaknesses in the early reaction studies.

Similarly, in his analysis of the various potential monetary 'instruments' in the Appendix to his major study, Jonson, by failing to correctly define the proper instruments of monetary policy, leaves unanswered the question of the correct assignment of these instruments. That is, by dealing solely in terms of the money supply or the interest rate, Jonson is unable to infer any conclusions about the relative importance of various instruments of monetary policy for external or internal policy stabilization. Even the study by Nobay, which is significant in its discussion of the problems of instruments versus intermediate targets, fails to explicitly study the assignment of monetary instruments between internal and external targets.

3.3.3 Summary

The Friedman-Meiselman and Andersen-Jordan studies evoked a large amount of criticism; the most important aspect of which centred around the problem of defining a truly exogenous monetary variable. Rhomberg accurately establishes this inherent problem by arguing that the instruments of stabilization policy cannot be perfectly exogenous, since, if they are, they cannot be conducive to stabilization. This problem is also carefully examined by Goldfeld and Blinder who emphasize that the problem of endogeneity is more likely to exist in monetary variables because the decision period for monetary stabilization policy is often shorter than the quarterly data period used in most econometric models. The continual arrival, and subsequent revision, of new data relating to the settings of monetary stabilization policy serves to impart a contemporaneous correlation between the policy variables and the disturbance term. Such a contemporaneous correlation occurs in those cases where the policy makers react immediately (with no lag) to these changing economic conditions.

Goldfeld and Blinder stress that any monetary-fiscal policy analysis is best carried out with the aid of a structural model rather than by simple reduced form analysis, typified by the Andersen-Jordan study. Unfortunately, the endogeneity problem still exists in structural models, unless the so-called 'reaction functions', describing the manipulation of the policy instruments in reaction to movements in targets of policy, are introduced into these models.

A review of previous reaction function studies reveals that many flaws exist in their construction. The most important of these is the incorrect treatment of 'intermediate targets' as 'instruments', combined with the assumption of an unambiguous and strong link between such targets and the ultimate goals of policy to which they are related. These flaws, in turn, have led to reaction function studies which are deficient in at least two respects:

(i) they incorrectly define the instrument variable. This will obviously result in inconsistent conclusions from the study;

(ii) they ignore the problem of *assignment* of monetary policy instruments. This deficiency automatically flows from (i).

The following chapter discusses appropriate monetary instruments and targets for Australian reaction functions and details problems associated with data and estimation of such functions.

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CHAPTER 4: AN AUSTRALIAN MONETARY POLICY REACTION FUNCTION

In the previous chapter some early monetary policy reaction function studies were analysed within the context of the problem of endogeneity first discussed in Chapter 2. Several of the problems and basic shortcomings of these reaction function studies were highlighted, particularly in regard to the choice of an appropriate policy instrument and the lack of any study of the 'assignment' problem associated with monetary policy instruments.

This chapter deals with the major problem of identifying appropriate policy instruments. Background on the possible choices open to the Reserve Bank is presented, and two monetary instruments are defined. The differing impact of the two instruments on the money supply is demonstrated within the context of a simple model of money supply determination. This demonstration highlights the importance of using a disaggregated approach and reveals the necessity to consider an assignment of monetary policy instruments to problems of internal and external balance. The problems of data and estimation are then considered and the form of the function to be estimated is established.

The following analysis centres on the reaction of the monetary policy instruments. In Appendix 4B, it is demonstrated that fiscal policy instruments show little, if any, current quarter reaction between government expenditure and any of the suggested economic targets. There is, however, some evidence of a reaction to the long term growth target. Moroney and Mason [14] have already discussed this problem and conclude that, within the confines of a quarterly model, it is unrealistic to treat government expenditure as endogenous. For this reason, the problem of instrument endogeneity is discussed in terms of monetary policy only.

4.1 Instruments of monetary policy in Australia

The central banking authority in Australia, the Reserve Bank, has the function of controlling the money supply, and thus the rate of interest and the cost of borrowing. The Bank regulates liquidity in the following ways:

(a) by controlling bank lending

(b) by the use of bank interest rate policy

(c) by supervising savings bank investment policy

(d) by regulating trading bank liquidity

(e) by the use of open market operations.

The Reserve Bank has the power to determine the lending policies of the trading and savings banks. This is achieved through directives outlining the classes of purposes for which advances can or cannot be made. By these means, the Bank can influence both the volume and the distribution of bank advances. Generally, however, such a policy of controlling bank lending by this method relies on the co-operation of the banks in adhering to the stated policy objectives. Similarly, the Bank has the authority to control the rates of interest paid or received by banks. Maximum rates are fixed after discussion between the Reserve Bank and the banks, and the banks are then required to observe these maximum rates. Within the maximum rate, the banks can vary rates for certain borrowers or classes of borrowers. Any change in the maximum rate, however, will usually induce a similar movement in other lending rates in the same direction and basically by the same amount. The Reserve Bank also supervises the investment policies of the savings banks by requiring these banks to maintain, in prescribed assets, an amount equal to not less than the amount on deposit in Australia with that bank.

The methods (d) and (e) by which the Reserve Bank implements its monetary policy are the more important. The Bank regulates bank liquidity directly by use of the Statutory Reserve Deposit System (SRD) in combination with the LGS (liquid assets and Government securities) convention. Also, by its presence in the trading of financial assets, the Bank affects financial market conditions. This influence is exercised by means of the buying and selling of Government securities whereby, it seeks to either support existing market conditions or to induce appropriate changes in these conditions. These two methods of implementing monetary policy are the most often used and constitute almost the whole thrust of monetary policy in Australia. The two instruments concerned, the Statutory Reserve Deposit Ratio (SRD) and open market operations (S) are discussed in detail in sections 4.1.1 and 4.2.1 below, and their impact on the money supply is then analysed within the context of an Australian model of money supply determination.

4.1.1 The SRD instrument

Each of the trading banks subject to the Banking Act is required to maintain a Statutory Reserve Deposit with the Reserve Bank. Such a deposit, the minimum amount of which is determined by the Reserve Bank, is expressed as a percentage of the banks' current level of Australian deposits. The SRD ratio is uniform for all the major trading banks. The important 'lever', by which the SRD instrument is made effective, is the LGS convention. Under this convention, each bank undertakes to hold a certain proportion of its total deposits in the form of liquid assets and Government securities. These assets consist of notes and coin, cash deposited with the Reserve Bank, Government Treasury bills and notes, and other Government securities. Each bank ensures that the LGS ratio (i.e. the ratio of LGS assets to deposits) does not fall below an agreed minimum which, again, is uniform for all banks. The importance of the LGS convention lies in the fact that it places some restriction on the banks' responses to SRD action implemented by the Reserve Bank.

Any change in the SRD ratio alters the level of trading bank cash. An increase (decrease) in the ratio causes the banks to reduce (increase) their holdings of cash, and ultimately to possibly reduce (increase) their other assets. The importance of the LGS convention enters at this stage. If the LGS assets held by the banks just approach the prescribed conventional minimum, a call to the SRD accounts (i.e. an increase in the SRD ratio) can usually only be met by a reduction in the holdings of other assets, particularly loans to clients. This makes it extremely difficult for borrowers to finance their spending.

The implementation of SRD policy can, however, be partially offset by the presence of excess LGS assets. Under these circumstances, a call to SRD can be satisfied by the commercial banks running down their excess LGS assets which are usually held as Government securities. Thus, a call to SRD accounts may be satisfied by the banks selling some of their surplus securities. Under these circumstances there is no effect on other assets such as bank advances. This action will, however, leave the banks less liquid. Moreover, because they sell a proportion of their assets to the private sector to obtain the funds, the private sector becomes less liquid. Such action can also restrict the capacity of the banks to lend in the future as the LGS assets approach the conventional minimum.

4.1.2 Open market operations

Open market operations are transactions in Government securities by the Reserve Bank with other sectors of the economy. Such transactions seek to influence the liquidity of the economy and may also be designed to affect the structure of interest rates. A sale of securities by the Reserve Bank serves to soak up excess liquid assets and reduces the reserves available to the private sector. Conversely, a purchase of securities by the Reserve Bank serves to substitute cash for Government securities in the private sector's portfolio. Such action leads to a re-arrangement of the private sector's asset holdings which results in increased loans by the banks and other intermediaries.

Open market operations are also designed to influence the interest rate structure. The Reserve Bank is able to reduce or increase upward pressure on interest rates by becoming either a willing buyer or or seller of securities. Tighter or easier conditions in the bond market are subsequently transmitted to other areas of the capital market, and private interest rates respond accordingly.

4.2 The *modus operandi* of monetary policy in a simple model of money supply formation

4.2.1 A model of the Australian money supply

The assets and liabilities of the Reserve Bank - the monetary base - form the basis of the money supply determination model. The assets of the Reserve Bank (the sources of the monetary base) are given by:

$$B = S + G + A - (K + OL) + C^P \tag{4.1}$$

and the liabilities (the uses of the monetary base) are given by

$$B = R + C^P \tag{4.2}$$

where B = monetary base

S = Reserve Bank holdings of Government securities

G = Reserve Bank holdings of gold and foreign exchange

$R = R^e + R^s$ = total reserves of trading banks held at the Reserve Bank

R^e = excess reserves of trading banks held at the Reserve Bank

R^s = statutory reserves of trading banks held at the Reserve Bank

C^P = notes and coin in the hands of the public

A = Reserve Bank lending to the banks

K = Reserve Bank capital

OL = Reserve Bank other liabilities.

The money supply (M), narrowly defined, is given by

$$M = D^P + C^P \tag{4.3}$$

where D^P = deposits in trading banks.

The Statutory Reserve Deposit ratio can be defined as

$$SRD = \frac{R^s}{D^P} \tag{4.4}$$

Similarly, we can define the excess reserves ratio and the currency ratio for the public sector as, respectively

$$r^e = \frac{R^e}{D^P} \tag{4.5}$$

and

$$k = \frac{C^P}{D^P} \tag{4.6}$$

The LGS convention as agreed upon by the banks is expressed in the form of the LGS ratio (ϕ)

$$\phi = \frac{N + S}{D^P} \tag{4.7}$$

where N = liquid assets of the banking sector.

This ratio is kept at or above some agreed minimum level (ϕ^*)

$$\phi \geq \phi^*$$

Individual banks hold excess reserves in the form of excess LGS assets. These are maintained in Government Securities. Thus the excess reserves of the banks is the margin between the actual LGS ratio (LGS_A) and the conventional minimum (LGS^*).

$$r^e = (\phi - \phi^*) = \frac{LGS_A - LGS^*}{D^P} \tag{4.8}$$

The relationship between the supply of money (M) and the monetary base (B) is obtained in the following way. From (4.2), (4.3) and (4.6) we know

$$B = R + C^P$$

$$M = C^P + D^P$$

and

$$k = \frac{C^P}{D^P}$$

Hence $\quad C^P = kD^P \qquad (4.9)$

$$\therefore \quad M = kD^P + D^P \qquad (4.10)$$

$$\therefore \quad D^P = \left(\frac{1}{1 + k} \right) M \qquad (4.11)$$

From the definition, we know

$$R = R^e + R^s$$

$$\therefore \quad R = r^e \cdot D^P + SRD \cdot D^P$$

$$\therefore \quad R = (r^e + SRD) \cdot D^P \qquad (4.12)$$

From (4.2) again, we have

$$B = R + C^P$$

$$\therefore \quad B = (r^e + SRD)D^P + kD^P$$

and, after inserting (4.12) and (4.9) into (4.2) we obtain:

$$B = (r^e + SRD + k)D^P$$

$$\therefore \quad D^P = \left[\frac{1}{(r^e + SRD + k)} \right] B \qquad (4.13)$$

Substituting (4.13) into (4.11) gives

$$\left[\frac{1}{r^e + SRD + k} \right] B = \left[\frac{1}{1 + k} \right] M$$

Rearranging gives us the desired relationship between M and B:

$$M = \left[\frac{1}{r^e + SRD + k} \right] B \qquad (4.14)$$

4.2.2 SRD policy in relation to the model

Expression (4.14) shows that, if the Reserve Bank wishes to reduce the money supply by increasing the SRD ratio, the ultimate effect will be to reduce the monetary multiplier. The change in the monetary base is zero and all the reduction in the money supply occurs as a result of the decline in this monetary multiplier. This result is dependent on the assumption that the trading banks have no excess reserves in the form of excess LGS assets. If the trading banks do hold excess reserves, then the impact of the SRD change is negated by the banking sector since the banks can meet the additional liability to SRD by selling some of their Government securities or by reducing their liquid assets.

4.2.3 Open market operations in relation to the model

Suppose the Reserve Bank wishes to reduce liquidity by the use of open market operations. To achieve this, it must sell securities to the public sector. Such an action reduces the assets of the Reserve Bank and, as such, reduces the sources of the monetary base:

$$\downarrow B \;=\; \downarrow S + G + A - (K + OL) + C^P$$

The public sector buy the Government securities from the Reserve Bank for cash, and hence C^P in equation (4.2) is reduced:

$$\downarrow B \;=\; R + \downarrow C^P$$

Thus, from (4.14) above, the decline in B reduces the money supply with no change in the monetary multiplier.

The difference between the two instruments results from their effect on the monetary base of the Reserve Bank. The SRD instrument has no impact on the base, whilst open market operations serve to change the monetary base. From this point of view, it is obvious that the criticism of many of the previous reaction function studies is warranted, on the ground that these studies use a monetary indicator as the policy *instrument* when, in effect, it is an intermediate *target*. This criticism applies particularly to the work of Dewald and Johnson [5], Reuber [17] and Havrilesky [8]. All of these studies make use of the money supply as an instrument of monetary policy. The use of the money supply as an instrument of policy in Australia however, would fail to distinguish between the effects due to the SRD instrument and the effects due to the open market instrument. For these reasons the SRD ratio and open market operations can be seen to be the true *instruments* of monetary policy. Reaction functions for these instruments are estimated in Chapter 5.

4.3 The problems of data, seasonality and estimation

In this section, the various problems associated with the formulation and estimation of the reaction functions are discussed. There are several main themes: the form of the reaction functions, their estimation and the problem of seasonality in the data used. A discussion of the data used in the estimation is also set out in Section 4.3.2.

4.3.1 Specification of the Reaction Functions

The specification of the reaction functions follows the standard pattern of relating targets and instruments.[1] One notable exception in this particular formulation, however, is the treatment of the interest rate (R) as an intermediate target rather than as an instrument. Under this framework the interest rate is partially controlled by the Reserve Bank but is also influenced by conditions prevailing in Australian financial markets. The consequence of this approach is that R is treated exogenously for econometric purposes.

The functions are specified to test for an endogenous reaction of the two monetary instruments to general economic conditions. The general targets of the study, designed to represent the appropriate economic conditions, are the rate of unemployment (U), the level of foreign reserves (FR) and the price level (P). The short term interest rate (R) is also tested as an intermediate target. Previous reaction function studies incorporate a growth target in the form of GNP, or its deviation from some long-term desired level. However no attempt is made, in this study, to test for a reaction to the growth target for the following reasons. Firstly, as Hosek [9, p. 18] argues, the inflation, employment and growth objectives may be interdependent. Faster rates of growth are associated with lower rates of unemployment for example, and *vice versa*. Secondly, the inclusion of a growth target is not compatible with an analysis which emphasizes short-run quarter-to-quarter reaction of targets to monetary policy. The idea of a growth target is generally of a longer run nature and is usually

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1. For a derivation of the form of the reaction function, see Appendix 4A.

accepted as one of the targets of fiscal policy rather than monetary policy. Finally, the inclusion of an income or GNP variable may not be acceptable in terms of the 'target-instrument' approach adopted here. Jonson [11, p. (vi)] suggests that the inclusion of such a variable may be taken to represent an accommodation of money supply to demand, rather than genuine stabilization response.

The question of a similar or dissimilar reaction by the two instruments to the economic targets is crucial to the case for or against the use of a disaggregated view of the monetary aspects of economic policy. If the reaction of the two instruments is similar, then there is a stronger argument for using an aggregated monetary view of economic policy in terms of, for example, the money supply. Such a result supports the approach taken in the earlier reaction function studies and, in particular, the ideas put forward in the Australian study by Jonson. If, on the other hand, the reaction of SRD and S to the targets of policy is different, then the case for using an aggregative money supply approach is weakened. Such a result, in this case, strengthens the argument for treating an investigation of the effects of monetary policy in terms of the individual instruments.

One other important feature of the specification of the two reaction functions relates to the potential interdependency between the instruments and the intermediate target; the rate of interest. Naturally, if these interdependencies do exist, then they should be accommodated in any policy formulation exercise. In order to test for these possible interdependencies, the equation for the open market instrument (S) is tested with the intermediate target (R) and the SRD instrument as explanatory variables, along with the two other economic targets.

Similarly, the equation for the SRD instrument contains both R and S. The important criteria for these tests will be the sign and significance of the coefficients in each particular equation. If the sign is correct, we can expect an increase in the SRD ratio to induce a net sale of securities. That is, the coefficient of the SRD instrument in the S equation should be negative, thus indicating that the induced reaction in S is in harmony with the original policy intention of contracting the money supply. A positive sign for SRD in the S equation indicates that the induced change is running counter to the original policy intention. A similar argument can be advanced for the insertion of the S instrument in the SRD equation.

Previous reaction function studies, with the exception of Nobay [15], ignore the possibility that the monetary authorities may set their policy instruments in an interdependent manner. The early study by Dewald and Johnson [5] made some progress in this regard by including the money supply, which they previously treated as an instrument, in another of their tested reaction functions. Many of the studies test only one 'instrument', but it is realistic to assume that the monetary authorities have more than one instrument at their disposal. Nobay [15, pp. 296-297] suggests that it is also unrealistic to suppose that the various instruments of policy are set independently. Such an assumption presupposes that the instruments are not structurally linked and that any alteration to one instrument has no impact on the others. In practice it is preferable to assume that movements in one particular instrument *will* affect the others and that, in such cases, the policy maker will treat these other instruments as *targets*. Although the monetary authorities can vary the policy instruments at will, there are costs involved in doing so. Thus, the values and movements of other instruments will be taken into account when changes in any one instrument are contemplated.

The role of the interest rate variable (i.e. the intermediate target), in the two reaction functions, should also provide some basis for analysing the differing nature of the operation of the two instruments. The open market policy instrument is represented by the Reserve Bank's holdings of Government Securities. This instrument is basically a market orientated technique. Hence, we can expect to find a relationship between this instrument and the interest rate. This result is due to the fact that open market operations are only feasible if the bond 'price', set by the Reserve Bank, is adjusted to achieve the desired policy objective of withdrawing funds from, or injecting funds into, the private sector. The recent developments in the bond market, resulting in a wider holding of bonds, and a greater willingness of the public to accept variations in interest rates, have facilitated the increased use of open market operations as a policy instrument. The operation of SRD policy is less directly associated with interest rates as such a policy operates almost exclusively on the availability of trading bank credit. Hence, if this *a priori* reasoning is correct, there are political costs associated with open market operations which take the form of interest rate adjustments. Such political costs are not associated with the use of the SRD instrument.

Using this argument, the reaction functions can be formulated as follows:

$$S_t = a_0 + a_1U_t + a_2P_t + a_3FR_t + a_4R_t + a_5SRD_t \tag{4.15}$$

$$SRD_t = b_0 + b_1U_t + b_2P_t + b_3FR_t + b_4R_t + b_5S_t \tag{4.16}$$

One further aspect of importance in this reaction function study relates to a comparison between the form of the endogenous reaction in those periods when the policy intention is expansionary, and the form of the reaction in those periods when the policy intention is contractionary. Such a comparison will enable a clearer understanding of whether, in fact, any endogenous reaction, which is present, is symmetrical or not. That is, the comparison will help determine whether the nature of the instrument reaction to the economic targets varies between periods of monetary contraction and expansion. Such an approach would suggest functions of the following form:

$$S_t = c_0 + c_1U_t^e + c_2U_t^c + c_3P_t^e + c_4P_t^c + c_5FR_t^e + c_6FR_t^c + c_7R_t^e + c_8R_t^c + c_9SRD_t^e + c_{10}SRD_t^c \quad (4.17)$$

$$SRD_t = d_0 + d_1U_t^e + d_2U_t^c + d_3P_t^e + d_4P_t^c + d_5FR_t^e + d_6FR_t^c + d_7R_t^e + d_8R_t^c + d_9S_t^e + d_{10}S_t^c \quad (4.18)$$

where the superscripts 'e' and 'c' represent the variables in expansionary and contractionary periods respectively.

Although the formulation of the two reaction functions appears to be straightforward from the preceding discussion, there is one important issue which must be resolved *ab initio*. This concerns the problem of whether the monetary authority reacts to changes in the absolute price level (P) or to movements in the rate of inflation ($\dot{P}$). The majority of the earlier formulations of the target-instrument approach to policy reaction functions have taken the price level as the appropriate policy target. For example, the functions formulated by

Wood [19], Dewald and Johnson [5], Havrilesky [8] and Froyen [7] all incorporate general price indices as their ultimate price stability targets. The Australian study by Jonson [11] also makes use of the general Consumer Price Index. However, it is possible that reaction functions formulated in such a way may be misspecified, since the monetary authority may react to movements in the rate of inflation rather than to movements in an index of prices. The use of a price level target suggests that the monetary authority has a certain target value for the price index for each quarter. Such an approach appears disingenious, as it suggests also, that the monetary authority fails to distinguish between upward and downward movements in the rate of inflation. That is, it appears illogical to argue that the authority reacts solely to an index of the price level, which has a continual upward trend, whilst ignoring the fact that the actual rate of inflation may have dropped. Instead, a desired rate of inflation appears to be a more plausible target.

If these arguments are correct, and the monetary authority does respond to movements in the rate of inflation rather than the price level, then it may be more correct to specify the reaction functions in terms of a rate of inflation target ($\dot{P}$), where this target is measured by the proportional annual rate of change of the consumer price index.

Since arguments can be advanced for either approach, and in order to compare the two alternative formulations, data is fitted to functions where the rate of inflation represents the desired price target:

$$S_t = e_0 + e_1 U_t + e_2 \dot{P}_t + e_3 FR_t + e_4 R_t + e_5 SRD_t \quad (4.19)$$

$$SRD_t = f_0 + f_1 U_t + f_2 \dot{P}_t + f_3 FR_t + f_4 R_t + f_5 S_t \quad (4.20)$$

4.3.2 Data sources, definitions and the problem of seasonality

The time series for the data covers the period 1961(1) to 1974(4). All data used is of a quarterly nature, in order to capture the short-run response of the monetary policy adjustment to changing economic conditions. Monthly data is unavailable for all the variables used in this study. The use of monthly data would, anyway, be unrealistic in terms of the length of the policy planning period envisaged for the monetary authorities. The quarterly data figures are taken as those at the end of each quarter. An alternative to this would have been the use of the four-quarter-moving average method which would have served to eliminate a degree of seasonality from the data. However, the seasonality, inherent in the data, can just as suitably be removed with the use of seasonally adjusted data. The general problem of seasonality is discussed after a description of the data.

Observations on the foreign reserves target are in current prices, as are the observations on the level of Reserve Bank holdings of Government Securities. This approach is adopted since it is the nominal value of the instruments which is directly controlled by the monetary authorities.

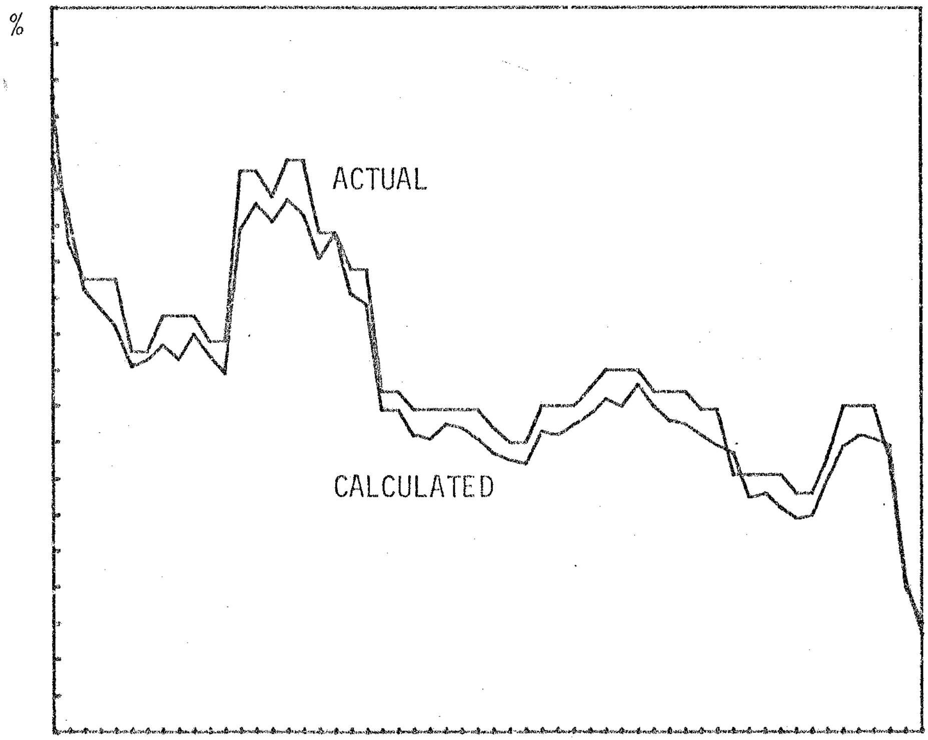
The open market instrument (S) is defined as Reserve Bank holdings of Government Securities. This instrument, however, should ideally be net of internal transactions with the Treasury and Trust funds. Reserve Bank holdings of Government Securities may change, even though there are no open market operations with the private sector. The published series includes the securities held as a result of these internal transactions. However, it was not possible to obtain details of these transactions, and thus, the data for S may be slightly distorted.

Observations on the actual value of the SRD instrument as set by the Reserve Bank cannot be observed systematically over the quarter long data period. This problem arises because of the non-systematic and often rapid variations in the set value of the instrument. One solution to this problem would be to average the value of the changes in SRD during each quarter to obtain an average end of quarter value. Such an approach is not practical, however, as there are several instances over the time period when the SRD instrument has not moved in the course of the three-month data period. Such examples are in the minority, but they would still serve to exacerbate the problem of settling on a value of the SRD instrument at the end of each quarter. The SRD instrument used is therefore calculated from total statutory reserves of the Trading Banks as a percentage of total Reserves of the major Trading Banks. Such a calculated value of the SRD ratio will tend, more accurately, to reflect the direction of SRD policy. The value of the calculated SRD ratio is an important indication of the adherence of the Trading Banks to SRD policy. The actual value of the SRD ratio and the calculated value are compared in Figure 4(1) below. The two values are observed to be closely correlated.

The foreign reserves target is defined as total gold and net foreign assets. Such a definition is broken into two measures of international reserves; the *official reserve assets*, and *other net*

FIGURE 4(1)

Actual and Calculated SRD
1961(1) to 1974(4)



Source: Reserve Bank *Statistical Bulletins* [3].

foreign assets. The first and major component of the official reserve assets is the gold and foreign exchange holdings of the Reserve Bank. This component includes gold, cash balances in London, deposits with overseas banks, money lent on the London money market and securities investments in overseas countries. The gold and foreign exchange holdings form the main component of Australia's international reserves, and any trend in its movement reflects whether these reserves are rising or falling. Official reserve assets also include Australia's holdings of Special Drawing Rights issued by the I.M.F., gold holdings of the Trading Banks and the government and Australia's gold tranche position with the IMF. Other net foreign assets consist of the net assets of the Trading Banks and government balances on deposit with the Reserve Bank.

The interest rate target is defined as the theoretical yield on Australian Government rebate bonds with two years to maturity. The inflation target is defined as the proportional change in the Consumer Price Index expressed on an annual basis. The alternative formulation defines the price target as the Consumer Price Index. The unemployment target is defined as the percentage of the workforce unemployed, and includes school leavers.

Data on the foreign reserves and unemployment targets is obtained from the Australian Bureau of Statistics publication, *Seasonally Adjusted Indicators* [1]. The data on Government Securities held by the Reserve Bank and the information necessary for the calculation of the SRD ratio is obtained from the Research Department of the Reserve Bank. The Consumer Price Index figures are obtained from the relevant ABS publication [2], and the data on the interest rate is obtained from various copies of the Reserve Bank *Statistical Bulletin* [3].

One further important aspect of the data problem relates to the question of whether seasonally adjusted or unadjusted data should be used. Seasonally unadjusted data is often preferred [16] because it permits seasonal, as well as other, movements to be explained by economic variables. On the other hand however, seasonally adjusted data helps to exclude Seasonal influences from any policy reaction to economic targets. All remaining reaction to these targets can, more accurately, be specified as a policy reaction rather than merely a seasonal reaction.

Wood [19, pp. 145-6], in his study of Federal Reserve actions, argues that the problem of seasonality is a difficult one. On the one hand, certain actions by policy makers are likely to be directed at offsetting the seasonal movements in such things as the money stock. The removal of the seasonal variation from these instruments would appear to suppress information of interest, and cause the results obtained to be distorted. On the other hand, Wood argues that there is ample evidence of the Federal Reserve responding to seasonally adjusted policy targets, especially the unemployment and foreign reserves targets. This argument does not extend to the price level because the amount of systematic seasonal variation in aggregate price indices is insignificant. Wood's argument is that the Federal Reserve does not react to seasonal variation in targets.

This view is supported by Friedlaender [6] who suggests that the relevant stabilization authority responds primarily to seasonally adjusted data where these are available. When seasonally adjusted data are not available, Friedlaender suggests that no attempt should be made to adjust it. Instead, it is assumed that the policy maker responds to the unadjusted data and therefore to the seasonal variation in the targets.

4.3.3 Method of estimation

The application of ordinary-least-squares (OLS) to the estimation of equations (4.15) to (4.20) proved abortive because of the presence of positive autocorrelation which is indicated by the Durbin-Watson statistic. One of the most important assumptions of OLS is that successive values of the disturbance term are independent of previous values [13, pp. 243-66]. If this assumption does not hold and the value of the disturbance term in a particular period is correlated with its previous value, then autocorrelation is present in the disturbance term. When autocorrelation is present, the parameter values of OLS are unbiased, although the variances of the parameter estimates are biased downward. That is, a variable coefficient may erroneously be classed as reliable when, in fact, it is not.

The problem is countered, in this particular instance, by modifying the method of estimation. Consider equation (4.15):

$$S_t = a_0 + a_1U_t + a_2P_t + a_3FR_t + a_4R_t + a_5SRD_t + \varepsilon_t$$

where ε_t is the disturbance term.

In the first instance, the adjustment is made by applying a first order autoregressive scheme as follows:

$$\varepsilon_{it} = \rho\varepsilon_{it-1} + V_{it} \tag{4.16}$$

where $i = 1, 2, 3$ and V_{it} possesses the classical disturbance properties. A Cochrane-Orcutt [4] transformation is then applied by lagging the original equation, pre-multiplying by ρ and subtracting from the original equation to give:

$$\begin{aligned} S_t = {} & a_0(1 - \rho) + a_1U_t - a_1\rho U_{t-1} + a_2P_t - a_2\rho P_{t-1} + a_3FR_t \\ & - a_3\rho FR_{t-1} + a_4R_t - a_4\rho R_{t-1} + a_5SRD_t - a_5\rho SRD_{t-1} \\ & + V_{it} \end{aligned} \tag{4.17}$$

where V_{it} is, by assumption, serially independent and autocorrelation is successfully eliminated.

This relationship is then estimated[2] and the value of ρ tested for significance. If ρ is found to be statistically significant the estimates of a_0, a_1, a_2, a_3, a_4, a_5 and ρ, obtained from the estimation, are used in place of those obtained from the original OLS estimation.

In equations (4.15), (4.16), (4.17), (4.18) and (4.19), the estimated value of ρ is found to be statistically significant and less than one. However, autocorrelation is still detected in equation (4.20) following the application of this first order adjustment with $\hat{\rho}$ exceeding unity. A second order autoregressive scheme is applied as follows:

$$\varepsilon_{2t} = \rho_1\varepsilon_{2t-1} + \rho_2\varepsilon_{2t-2} + V_t$$

where V_t once again possesses the classical disturbance properties. The second-order scheme is applied to equation (4.20) and the estimation is again performed by non-linear-least-squares. Autocorrelation is, this time, successfully eliminated as the necessary and sufficient conditions for covariance stationarity are satisfied at the 5 percent level of significance as follows:

$$\hat{\rho}_2 + \hat{\rho}_1 < 1; \qquad \hat{\rho}_2 - \hat{\rho}_1 < 1; \qquad \hat{\rho}_2 > -1$$

4.4 Summary

The preceding discussion suggests reaction functions which test the reaction of the two true instruments of monetary policy in Australia (SRD and S) to an external target, an inflation target, an unemployment target and an interest rate variable. The problem of

2. The non-linear-least-squares program used for this estimation was written by Mr. D. W. Challen of the Economics Department, University of Tasmania.

seasonality is discussed, along with the choice of a suitable price target.

The estimates of the equations are presented in the next chapter, and the results of the estimation are discussed in detail.

APPENDIX 4A

THEORETICAL BACKGROUND TO FORM OF REACTION FUNCTIONS

The theoretical underpinnings of the reaction function form can be derived from the constrained minimization procedure developed by Theil [18]. This procedure assumes that the policy maker attempts to minimize the weighted sum of the squared deviation of both targets and instruments from their desired values. The quadratic preference function is of the following form.

$$d = \alpha'(X - X^*) + \beta'(Y - Y^*) + \tfrac{1}{2}[(X - X^*)'A(X - X^*) + (Y - Y^*)'B(Y - Y^*)]$$

where X = $(m \times 1)$ vector of the actual values of the policy instruments

X^* = $(m \times 1)$ vector of the desired values of the policy instruments

Y = $(n \times 1)$ vector of actual values of the target variables

Y^* = $(n \times 1)$ vector of desired values of the target variables

A = $(m \times m)$ diagonal matrix of weights attached to the squared deviations of desired from actual values of the policy instruments

B = $(n \times n)$ symmetric matrix of weights attached to the squared deviations of desired from actual values of the target variables

α = $(m \times 1)$ vector of weights attached to linear deviations of desired from actual values of the policy instruments

β = $(n \times 1)$ vector of weights attached to linear deviations of desired from actual values of the target variables.

However, the quadratic preference function used as the theoretical basis in this present study assumes that the policy maker does *not* pre-suppose desired values for either the targets or the instruments.

Consequently, the preference function assumes the form

$$d = \alpha'X + \beta'Y + \frac{1}{2}(X'AX + Y'BY)$$

The disutility minimization takes place subject to the constraints imposed by the economic structure. This view of the economic structure assumes the target variables to be linearly dependent on the policy instruments and the non-controlled predetermined variables which also include lagged values of the targets and instruments. This so-called 'policy model' can be written in matrix form as

$$Y = RX + VZ$$

where Y = (n x 1) vector of actual values of the target variables

X = (m x 1) vector of actual values of the instrument variables

Z = (k x 1) vector of non-controlled predetermined variables

R = (n x m) matrix of coefficients of the instruments

V = (n x k) matrix of coefficients of the non-controlled predetermined variables.

The substitution of the constraints into the utility function yields:

$$d = \alpha'X + \beta'(RX + VZ) + \tfrac{1}{2}[X'AX + (RX + VZ)'B(RX + VZ)]$$

$$\therefore \quad d = \alpha'X + \beta'RX + \beta'VZ + \tfrac{1}{2}[X'AX + X'R'BRX + X'R'BVZ + Z'V'BRX + Z'V'BVZ]$$

$$\therefore \quad d = \alpha'X + \beta'RX + \beta'VZ + \tfrac{1}{2}[X'AX + (X'R'B)(RX + VZ) + (Z'V'B)(RX + VZ)]$$

Minimizing the disutility with respect to the instruments, (X), yields

$$\frac{\partial d}{\partial X} = \alpha' + \beta'R + AX + R'BRX + R'BVZ$$

$$= (\alpha + R'B) + AX + R'BY$$

Note that this uses the first order conditions only. The second order conditions require the A and B matrices to be positive. This is usually established in setting up the problem.

Finding the optimal X, (X^0), by equating the vector of derivatives to zero, gives:

$$(\alpha + R'\beta) + R'BY = -AX^0$$

$$\therefore \quad X^0 = -A^{-1}[(\alpha + R'\beta) + R'BY]$$

Thus, every value of the 'optimal' instrument, X^0, is equal to a constant, plus a linear combination of the value of the targets.

APPENDIX 4B

GOVERNMENT EXPENDITURE REACTION FUNCTIONS

1. Previous Australian Studies

In a study of government expenditure reaction functions, Jonson [11] considers government non defence current and capital expenditure and relates these to the ratio of vacancies to total unemployment, the consumer price index, the level of foreign reserves, and a growth variable represented by Gross National expenditure. Jonson finds some evidence of a systematic manipulation of policy variables in accord with movements in the target variables. However, often the coefficients of the targets are either insignificant or their signs perverse. His findings, with respect to Government current expenditure, leads him to conclude that

> '... a positive response to growth dominates current Commonwealth spending and ... when only the stabilization variables are in the equation, they are proxies for Gross national expenditure'. [11, p. 15]

In the government non-defence capital expenditure equation, Jonson finds that none of the targets entered with the correct sign. Various tests lead him to believe that these targets are, once again, merely proxies for growth.

The other Australian study in this area is the one by Kelly [12] who experiments with capital and current defence and non-defence expenditure. Generally, Kelly finds little evidence to support any policy reaction to the general state of the economy. The large majority of his success is due almost entirely to the finding of a reaction of government expenditure to certain wage rates and the cost of government services. However, Kelly does experiment with the vacancies - unemployment ratio, the consumer price index, the proportionate rate of increase of the CPI (i.e. the rate of inflation) and the level of foreign reserves. None of the results obtained using these state of the economy variables are very successful.

2. Estimates of government expenditure reaction functions

Attempts were made to estimate a government expenditure reaction function using Commonwealth, State and local government (public authority) current expenditure on goods and services at current prices (G_t). The equation obtained was:

$$G_t = \underset{(\text{n.a.})}{-830.7186} + \underset{(3.1782)}{39.9692U_t} + \underset{(2.7336)}{12.8219P_t} + \underset{(2.5796)}{0.0391FR_t} + \underset{(18.2519)}{0.2309Y_t}$$

$$R^2 = 0.9940$$

$$\rho = \underset{(6.7973)}{0.6457}$$

where Y_t = real Gross Domestic Product and all other variables are as defined previously. The high significance of the growth target (Y_t) suggests that the reaction of G_t to the targets simply reflects a positive response to growth. In order to test this proposition, the government expenditure equation is re-estimated using the quarterly change in G_t as the dependent variable. The equation obtained is:

$$\Delta G_t = \underset{(\text{n.a.})}{-21.1112} - \underset{(0.4759)}{2.1823U_t} + \underset{(0.8789)}{1.4004P_t} + \underset{(2.2426)}{0.0099FR_t} + \underset{(1.2065)}{0.0045Y_t}$$

$$R^2 = 0.3545$$

$$\rho = \underset{(4.6154)}{-0.5370}$$

The significance of the growth target is reduced substantially; suggesting that the previous proposition is correct. The results obtained would appear to correspond to those obtained by Jonson, as it is apparent that much of the reaction of government expenditure is in response to a growth target. Hence, it can be concluded that the government expenditure instrument, in responding to a longer run target such as growth, can accurately be treated as exogenous, at least within the confines of a quarterly model.

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CHAPTER 5: RESULTS OF ESTIMATION

In this chapter, the results of the estimation of the reaction functions, specified in Chapter 4, are examined. Firstly, equations (4.15), (4.16), (4.19) and (4.20) are analysed to determine the appropriate price target. The preferred functions are then analysed in detail, in terms of their reaction to the various targets. The interdependence between the two instruments is examined, especially in connection with the interest rate variable, included as an intermediate target. The costs of adjustment of each instrument are analysed also. The time period is then split into phases of monetary contraction and monetary expansion and the functions are then re-estimated. Such an analysis is important in determining whether or not the response of each instrument is symmetrical during these phases.

5.1 Interpretation of results

The estimation of equations (4.15), (4.16), (4.19) and (4.20) yields the following results:

$$S_t = \underset{(\text{n.a.})}{-566.473} - \underset{(5.555)}{0.346FR_t} + \underset{(0.576)}{23.005R_t} + \underset{(0.349)}{13.569U_t} + \underset{(2.995)}{17.933P_t} + \underset{(0.475)}{7.057SRD_t} \tag{5.1}$$

$$\bar{R}^2 = 0.742$$

$$\rho = \underset{(4.746)}{0.584}$$

$$SRD_t = \underset{(\text{n.a.})}{21.312} - \underset{(1.959)}{0.123P_t} + \underset{(0.492)}{0.0003FR_t} - \underset{(2.303)}{1.082U_t} + \underset{(0.284)}{0.0003S_t} + \underset{(1.155)}{0.406R_t} \tag{5.2}$$

$$\bar{R}^2 = 0.865$$

$$\rho = \underset{(11.095)}{0.856}$$

$$S_t = \underset{(n.a.)}{803.358} - \underset{(4.208)}{0.195}FR_t + \underset{(3.467)}{125.045}R_t - \underset{(0.141)}{5.679}U_t$$

$$+ \underset{(0.102)}{1.859}\dot{P}_t - \underset{(1.508)}{19.364}SRD_t \tag{5.3}$$

$$\bar{R}^2 = 0.743$$

$$\rho = \underset{(4.346)}{0.558}$$

$$SRD_t = \underset{(n.a.)}{15.733} + \underset{(3.333)}{0.546}\dot{P}_t + \underset{(2.104)}{0.002}FR_t - \underset{(4.147)}{1.447}U_t$$

$$+ \underset{(1.120)}{0.001}S_t + \underset{(0.595)}{0.183}R_t \tag{5.4}$$

$$\bar{R}^2 = 0.0855$$

$$\rho_1 = \underset{(5.451)}{0.806}$$

$$\rho_2 = \underset{(1.556)}{0.138}$$

An analysis of the equations above suggests that the inflation variable is to be preferred to the price level as the appropriate target. A comparison of the equations for S indicates that the price level variable is significant in (5.1) but is of the *wrong* sign. That is, equation (5.1) implies that an increase in the price level induces a monetary expansion represented by a net increase in S. For this reason, equation (5.3) is taken to represent the reaction of the securities instrument to changing economic circumstances. The same kind of comparison can be made with the alternative SRD equations, (5.2) and (5.4). Equation (5.2) provides an estimated coefficient for the price level target with the *wrong* sign, suggesting that an increase in the price level induces a monetary expansion, represented by a reduction in the SRD ratio. On the other hand, when the rate of inflation is taken as the appropriate target in equation (5.4), it is of the *correct* sign and statistically more significant. This shows that an increase in the SRD ratio will occur in reaction to an increase in the rate of inflation. The above reasoning suggests that the rate of inflation is the more appropriate target. Thus, equations (5.3) and (5.4) are taken to represent the endogenous reaction of the open market instrument and the SRD instrument respectively.

5.2 Policy reactions in detail

The estimates of equations (5.3) and (5.4) indicate clearly that the responses of the two instruments to changes in economic conditions differ. From equation (5.3) it is obvious that the open market instrument responds very significantly to movements in the foreign reserves target. The relationship, in this case, is an inverse one indicating that an increase in the level of foreign reserves induces a net sale of securities. Thus, the open market instrument is used to *sterilize* the impact of a net capital inflow on the domestic money supply. The size of the coefficient of the foreign reserves target also implies that approximately 20 per cent of an increase in the monetary base due to an increase in the level of Australian foreign reserves is offset by a net sale of securities.[1] Reserve Bank statements, in connection with the use of the open market instrument, support the finding of equation (5.3) with respect to the assignment of this instrument to problems of external balance. For example, in 1963-64, the Reserve Bank reports that precautionary moves had been initiated to

1. The use of the open market instrument to offset or sterilize the effects of changes in international liquidity have also been well documented elsewhere. See, for example, Porter [6], Rowan [9] and McGregor, Burrows and Zecher [4].

'... contain and counter increases in the money supply which were largely the product of international transactions, and therefore not readily controllable at the source. The Bank sought, through its open market operations, and in coordination with debt management, to absorb funds by increased sales of Government Securities to the public.' [8, p. 15]

On the other hand, the open market instrument does not show any significant response to any of the domestic targets, namely the unemployment rate or the inflation target. In fact, the unemployment target is not only statistically insignificant, but it also exhibits an incorrect sign, indicating that an increase in the rate of unemployment induces a monetary contraction via a net sale of Government securities. The inflation target is statistically insignificant, although of the correct sign. Because of its poor statistical significance, however, it is not regarded as a target with which the open market instrument is closely associated.

The SRD instrument, in contrast to the open market instrument, exhibits a strong reaction to each of the domestic targets and the response, in each case, is of the correct sign. An increase in the rate of inflation, for example, induces a restrictive monetary policy as the SRD ratio rises in response to the increased inflation. Furthermore, an increase in the unemployment rate induces a monetary expansion brought about by a fall in the SRD ratio. These findings are also supported by Reserve Bank statements in regard to past use of the SRD instrument. Here emphasis is undoubtedly placed on the influence of the SRD ratio, on the overall state of liquidity in the economy, and the consequent implications of this for inflationary and growth tendencies. In 1963, for example, it is pointed out that

'... the paramount objective ... was to provide adequate financial support for a rising level of expenditure, so as to increase employment of labour and physical capacity ...' [8, p. 16]

Again, in 1969, the Reserve Bank makes it clear that adjustments to the SRD ratio are being made in reaction to certain pressures in the economy. This is made obvious by a statement that

> '... labour market statistics suggested that pressure on domestic resources was slowly increasing. The SRD ratio was therefore increased from 8% to 9% ...' [8, p. 28]

In 1970-71, it is reported that there is

> '... little evidence ... of easing in the growth of prices, and this continued to argue against any early relaxation in monetary policy.' [8, p. 6]

Equation (5.4) also suggests that the foreign reserves target is significant and of the *correct* sign. This indicates that the monetary authority has used the SRD instrument to reduce the secondary effects of increases in the external target. The estimated results suggest that the open market instrument has been used primarily for the purposes of offsetting or *sterilizing* the effects of increases in Australia's foreign reserves. On the other hand, the SRD instrument has been directed more towards the stabilization of fluctuations in the domestic economy. Such a finding reinforces the suggestion that there is a form of *assignment* of the two monetary policy instruments to internal and external targets.

5.3 Instrument Interdependencies

The estimates of the reaction functions, given by (5.3) and (5.4), also suggest an association or interdependency between the SRD instrument and the use of open market operations. Equation (5.3), for example, shows some evidence, although not strong, of a negative relationship between the SRD ratio and the Reserve Bank's holdings of Government Securities. Such a relationship indicates that the two instruments have worked in the same direction: an exogenous increase in the SRD ratio brings about a net sale of securities. Both these changes indicate a monetary contraction. Equation (5.4) reveals that the relationship is not symmetrical, since the open market instrument enters this equation with the *incorrect* sign. Such evidence suggests that the open market instrument is used to supplement, or reinforce, SRD action. In 1964, for example, with expansion increasing, the Reserve Bank sought to move more firmly, and on a wider front, against an over-increase in the supply of money. To carry out this policy

> '... the SRD ratio for major Trading Banks was increased progressively in the first three months of the year ... (and) ... *concurrently*, the focus of open market operations in Government securities was sharpened to contribute more effectively to the tightening of liquidity, the Bank becoming increasingly willing to meet buyers and more reluctant to accommodate those desiring to unload securities.' [8, pp. 15-16]

In 1968-69, use is also made of open market operations to absorb part of the increase in liquidity that is occurring. As the Reserve Bank points out

> '... the activities of monetary authorities in the bond market *supplemented* the cautionary measures implemented through the banking system.' [8, p. 5]

Again, in 1969-70, faced with inflationary tendencies, the Reserve Bank increases the SRD ratio and points out that

> '... furthermore, the Reserve Bank's operations in the bond market as a willing seller and a reluctant buyer of Government securities contributed towards tighter financial conditions.' [8, p. 2]

The reinforcing of SRD policy with supplementary action, by open market operations, is one aspect commented on by Nobay in his study of British monetary policy reaction [5]. Among his results, Nobay finds that open market operations serve, among other things, to reinforce

Special Deposit calls. In an earlier section of his paper, Nobay also comments on the individual flexibility of certain instruments and the extent to which they can be manipulated. Nobay emphasizes that movements of, and the impact on, other instruments must also be taken into account when one particular instrument is manipulated. In an Australian context, this could possibly explain the *harmonious* relationship between the SRD instrument and the open market instrument in equation (5.3). Similarly it explains the lack of any such relationship in equation (5.4). That is, the short-term flexibility of the SRD instrument[2] suggests that it is used extensively for internal stabilization. However SRD action can be supplemented or reinforced by the less flexible open market instrument. Hence, a change in the SRD ratio evokes an *harmonious* change in the open-market instrument. However, a change in the less flexible open-market instrument evokes no supplementary or reinforcing action from the SRD instrument.

One other aspect of the interdependency problem is also brought to light by the results of the reaction function estimates given by equations (5.3) and (5.4). This relates to the direct association between the open market instrument and the interest rate. Equation (5.3) clearly shows the market orientated nature of the open market instrument; an increase in the rate of interest inducing a net purchase

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2. Since the introduction of the SRD system in 1960, there is evidence to suggest that it has been used primarily as a short term instrument. Over the sample period of this study over half of all changes in the SRD ratio are made within time periods of less than 3 months of each other. Of course, many of these are planned 'step' changes, whereby the ratio is altered in successive steps.

of securities, thus having an expansionary effect on the money supply. This relationship demonstrates the accommodating nature of the money supply which expands or contracts as the demand for financial assets increases or decreases respectively. Equation (5.4) demonstrates, however, that this relationship does not exist between the SRD ratio and the rate of interest. The accommodating nature of the money supply, as suggested by equation (5.3), indicates a positive relationship between the supply of money and the interest rate.

These results have implications for the appropriate use of monetary policy by the monetary authorities. For example, according to the *rates* view of monetary policy, the interest rate and the SRD ratio can be regarded as the appropriate instruments of monetary policy. In each case, the outcome of a particular monetary policy change will be associated with differing costs of adjustment.
A monetary contraction (expansion) can be brought about by either raising (lowering) the interest rate or increasing (decreasing) the SRD ratio. Equation (5.3) suggests that as the interest rate is adjusted, an offsetting effect occurs in the open market instrument.
A contractionary monetary policy, brought about by increasing the interest rate, will result in a net *purchase* of securities by the Reserve Bank. This net purchase is due to asset substitution by the financial institutions in the finance sector as they attempt to convert some of their holdings of Government securities into more liquid assets. This sale of securities, by the finance sector, is designed to meet the exigencies of the financial restrictions imposed initially by the monetary authorities in the form of increased interest rates. Equation (5.4) suggests that such an action does *not* occur in the operation of SRD policy.

The outcome of this association between the interest rate and the open market instrument suggests that there are certain costs of adjustment associated with the use of each of the monetary instruments for contractionary or expansionary policy purposes. These costs of adjustment are highlighted by observing the symmetrical association between S and R. This is given in an estimate of the equation for the intermediate target (R) with the ultimate targets (U, $\dot{P}$ and FR) and the two instruments (SRD and S) as exogenous explanatory variables. This equation takes the following form:

$$\begin{aligned} R_t = \; & \underset{(n.a.)}{2.210} + \underset{(0.564)}{0.068U_t} + \underset{(8.219)}{0.330\dot{P}_t} - \underset{(0.432)}{0.001FR_t} \\ & + \underset{(4.239)}{0.002S_t} - \underset{(0.055)}{0.002SRD_t} \end{aligned} \tag{5.5}$$

$$\bar{R}^2 = 0.903$$

$$\rho = \underset{(2.608)}{0.382}$$

In this equation, only the rate of inflation and the open market instrument are significant. This equation is of considerable importance in determining the costs of adjustment for each of the instruments and thus, for determining the choice between SRD and S as alternative policy measures. According to equation (5.5) a monetary expansion, brought about by a net purchase of Government securities, has the effect of increasing the interest rate. On the other hand, a monetary expansion, brought about by a reduction in the SRD ratio, has *no* effect on the interest rate. Such a conclusion reinforces the lack of association between the SRD instrument and the interest rate which was originally observed in equation (5.4).

Burger [1, p. 126] suggests that such a phenomenon, as observed in equation (5.5), is due to a so-called 'spillover' effect. A monetary expansion, carried out by means of an open market purchase, although serving to reduce interest rates in the short run, will ultimately result in increased interest rates in the *long run*. This occurs because of the initial impact of the short run reduction in interest rates on investment and income. The resultant increase in income increases the demand for bank credit which ultimately puts pressure on the level of interest rates as firms compete for funds. Such a process, in the long run, results in increased interest rates, despite the initial expansionary policy. Burger's explanation of the 'spill-over' effect, observed in equation (5.5), is corroborated by Friedman [2, p. 75] who suggests that, as well as expansionary monetary policy ultimately resulting in increased interest rates, a contractionary policy, operating through the same channels, will result in reduced interest rates in the long run. This conclusion is examined in Section 5.4 below.

The lack of any mutual correlation between the SRD instrument and the interest rate, observed in equations (5.4) and (5.5) requires some comment. Unlike the open-market instrument, the SRD instrument is not market orientated. Despite this, it can be argued that an increase in the SRD ratio evokes a rise in interest rates as the trading banks reduce or restrict advances. Purvis [7, p. 79] suggests however, that the institutional setting in Australia alters the normally conceived chain of events which would result in the interest rate increasing. Such an alteration occurs because of the extent to which trading banks hold excess LGS assets and the extent to which these excess reserves are used as a *buffer stock* in their portfolios.[3] Purvis argues that the trading banks can sell their excess assets in order to meet the deficient SRD position, rather than by calling in advances. Such action reduces the likelihood of SRD policy resulting in increased interest rates during a contractionary monetary phase. Under these circumstances, private sector liquidity is still reduced, and Purvis suggests that this sets the stage for a successful open market sale, as higher administered interest rates induce an increase in the private sector's holdings of Government securities.

Purvis also argues that a similar situation exists in the use of open market operations as an alternative policy action. In the case of a contractionary monetary policy, open market sales are induced by an increase in interest rates. According to Purvis, however, the institutional arrangements, as they exist in Australia, preclude a market determined rate of interest. Purvis maintains that the monetary authority sets the interest rate (i.e. it treats R as an instrument) and then proceeds to sell or buy the amount of securities necessary to maintain this interest rate. Equations (5.3) and (5.5) both disagree with this point of view. Equation (5.3) suggests that the open market instrument responds to changes in the interest rate, and equation (5.5) observes that open market operations have the ultimate effect of increasing interest rates when the policy is expansionary.

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3. The problem of excess reserves and their effect on the operation of SRD policy is examined in Chapter 4.

5.4 Expansionary and Contractionary Monetary Reaction

From the evidence presented so far, it is not possible to state conclusively whether the arguments are symmetrical, and that a monetary *contraction*, achieved by selling securities on the open market, will be associated with a general *reduction* in interest rates. This is part of a more general problem, namely, that the form of the endogenous reaction will vary between contraction and expansion.

In order to investigate this aspect of the study the time series is split into periods of monetary policy contraction and expansion. The coefficients of the two reaction functions are estimated in both the contractionary and expansionary phases and the significance of the difference between the estimates is compared. In this way, it is possible to conclude that policy reaction differs, or is the same, in these contractionary and expansionary phases. The intention of policy has been associated with the movement in the SRD ratio. This is, increases in the SRD instrument are taken to indicate a monetary policy contraction, and decreases in the SRD are taken to indicate a monetary policy expansion. Purvis [7, p. 79] suggests that SRD calls have a history of being a signal for Reserve Bank monetary policy intentions. For example, an increase (decrease) in the SRD ratio would be taken, by the private sector, to indicate that a tighter (easier) monetary policy is being contemplated. This same criterion is used in splitting the time period in the contractionary and expansionary phases. Table 5.1 sets out the designated periods of contraction and expansion.

Table 5.1 shows that the policy intention, according to the movement in the SRD instrument, is expansionary in forty of the fifty-six

TABLE 5.I

Periods of Monetary Contraction and Expansion
1961(1) to 1974(4)

Policy Contractions	Policy Expansions
1964(1) to 1964(4)	1961(1) to 1963(4)
1969(1) to 1970(3)	1965(1) to 1968(4)
1973(1) to 1974(1)	1970(4) to 1972(4)
	1972(2) to 1974(4)

quarters in the time series, and contractionary in only sixteen. Hence, a separate estimate of the two reaction functions, in the contractionary phase, provides only eleven degrees of freedom. Because of this obvious econometric limitation, it is not feasible to attempt to estimate the two reaction functions for periods of expansion and contraction separately, and to then apply an F-test comparing the significance of the difference of the estimates in these contractionary and expansionary phases. Instead, the shift dummy approach [3, pp. 409-30] is used, thus enabling the division of the time series into periods of contraction and expansion whilst making use of the entire 56 observations.

The reaction functions which satisfy these requirements were set out in Chapter 4 as equations (4.17) and (4.18). In this format, the superscripts 'e' and 'c' represent the value of the variable during periods of monetary expansion and contraction respectively.

d_i $i = 1 \ldots 10$ represent the dummy variables assigned a value of zero or unity in the appropriate circumstances.

The value of d_i for the variables with the superscripts e(c) is unity in the expansionary (contractionary) phase, and zero otherwise. The disturbance term, ε_{it} is a random variable that satisfies all the basic assumptions of the classical normal linear regression model.

The estimates of (4.17) and (4.18) adjusted for serial correlation are as follows:

$$\begin{aligned} S_t = \; & \underset{(n.a.)}{1047.595} - \underset{(2.007)}{29.793}SRD_t^e - \underset{(1.100)}{16.974}SRD_t^c - \underset{(1.188)}{52.841}U_t^e \\ & - \underset{(1.105)}{155.282}U_t^c + \underset{(0.813)}{11.790}P_t^e - \underset{(1.651)}{32.521}P_t^c - \underset{(5.082)}{0.223}FR_t^e \\ & - \underset{(0.531)}{0.038}FR_t^c + \underset{(3.743)}{112.771}R_t^e + \underset{(2.127)}{78.076}R_t^c \end{aligned} \qquad (5.6)$$

$$\bar{R}^2 = 0.812$$

$$\rho = \underset{(7.223)}{0.748}$$

$$\begin{aligned} SRD_t = \; & \underset{(n.a.)}{0.407} + \underset{(0.989)}{0.002}S_t^e - \underset{(1.136)}{0.002}S_t^c - \underset{(4.599)}{1.803}U_t^e + \underset{(0.288)}{0.326}U_t^c \\ & + \underset{(1.785)}{0.338}P_t^e + \underset{(0.541)}{0.119}P_t^c + \underset{(0.777)}{0.001}FR_t^e - \underset{(0.400)}{0.001}FR_t^c \\ & - \underset{(1.142)}{0.398}R_t^e + \underset{(0.961)}{0.378}R_t^c \end{aligned} \qquad (5.7)$$

$$\bar{R}^2 = 0.873$$

$$\rho = \underset{(24.674)}{0.973}$$

The interpretation of equations (5.6) and (5.7) above tend to shed some additional light on the results obtained earlier. The equation for the securities instrument (5.6) once again reveals the significance of the foreign reserves target, and substantiates the assignment of the securities variable towards the external sector. In this instance however, the foreign reserves target is significant only in the phase which is characterized as one of monetary expansion. This phenomenon reflects the operation of the *sterilization* policy mentioned previously, and also reflects the attitude of the policy makers towards inflationary pressure. Open market operations are used in the monetary expansion phase to help dampen the inflationary effects of a large inflow of international finance. This inflow tends to stimulate the monetary or cash base with the resulting inflationary pressures. In the monetary expansion phase, therefore, the monetary authorities are more concerned in containing or countering those increases in the money supply which are, because of their origin, not readily controllable at the source. On the other hand, the foreign reserves target fails to be significant in the contractionary monetary phase.

Equation (5.7) shows up clearly the response of the SRD ratio to movements in the unemployment target. The SRD ratio reacts strongly to the unemployment target in the expansionary phase of policy. However, it does not react significantly to unemployment when the monetary authorities seek to contract the money supply. This apparently reflects the higher priority given to unemployment when the policy intention is expansionary. That is, unemployment has a heavier weight during an expansionary monetary phase and inflation is given lower priority. The significance of the unemployment and inflation targets suggest that there is a reversal of these priorities during the contractionary phase. Inflation is given a higher weight than unemployment. During this phase the unemployment target is not only less significant than the inflation target, but is of the incorrect sign. Neither target however, is highly significant.

The original finding of some evidence of interdependency between the SRD instrument and the open market instrument is again highlighted in equations (5.6) and (5.7). The harmonious relationship between SRD policy and open market policy, which suggested that SRD policy changes are followed or supported by open market operations, can be observed again in equation (5.6). On this occasion however, it should be noted that the harmonious relationship between the SRD instrument and open market operations is most strongly observed during times of monetary *expansion*. An harmonious, but less significant, relationship is observed also during contractionary monetary phases. The lack of any significant relationship in the opposite direction is again noticeable. However, in the contractionary period, the open market instrument is observed with a *correct* sign to suggest an harmonious relationship.

Further information is also gleaned on the relationship between the interest rate and each of the instruments. Equation (5.7) reveals, once again, the lack of any association between the interest rate and the SRD instrument either in a contractionary or an expansionary monetary phase. Such a finding again supports Purvis' contention that the use of SRD policy is independent of interest rate changes because of the existence of LGS and excess reserves which can be used as *buffer* stocks against a call to SRD. Equation (5.6), however, demonstrates the positive association between the interest rate and the open market instrument. This is consistent with equation (5.3). The additional information provided in equation (5.6) shows that the association between R and S is symmetrical; as R increases S also rises. In addition, however, as R falls, S also falls.

The problem of adjustment costs associated with each instrument can be approached in the same way. The equation for R, (5.5), can be modified to accommodate the distinction between expansionary and contractionary phases. This modified equation is as follows:

$$
\begin{aligned}
R_t = \; & \underset{(n.a.)}{0.398} + \underset{(1.277)}{0.058}SRD_t^e + \underset{(1.086)}{0.021}SRD_t^c - \underset{(0.366)}{0.042}U_t^e \\
& + \underset{(1.775)}{1.243}U_t^c + \underset{(4.405)}{0.210}\dot{P}_t^e + \underset{(5.959)}{0.376}\dot{P}_t^c + \underset{(1.964)}{0.0003}FR_t^e \\
& - \underset{(1.486)}{0.0004}FR_t^c + \underset{(5.299)}{0.003}S_t^e + \underset{(4.314)}{0.002}S_t^c \qquad (5.8)
\end{aligned}
$$

$$\bar{R}^2 = 0.883$$

$$\rho = \underset{(1.631)}{0.272}$$

Once again, only the rate of inflation and the open market instrument are significant. Equation (5.8) demonstrates that a monetary *expansion*, brought about by a net purchase of securities, will have the ultimate effect of *increasing* interest rates. A monetary *contraction*, brought about by a net sale of securities, will ultimately result in a *reduction* in interest rates. The coefficient of S^c is positive and highly significant, demonstrating the strong mutual association between S and R. On the other hand, it is observed again, in equation (5.8), that a monetary expansion or contraction, brought about by reducing or increasing the SRD ratio, will have no effect on the interest rate. Equation (5.8) therefore suggests that the contraction of the money supply, brought about by a net sale of securities, is associated with a negative cost of adjustment in the form of reduced interest rates. Thus, the 'spillover' effect described by Burger can be seen to work in *both* directions. The findings of equation (5.8) therefore substantiate Friedman's theory that the *long run* effect of a contractionary monetary policy will be to reduce interest rates.

5.5 Summary

The preceding analysis subsumes a disaggregated view of the monetary aspect of economic policy. In this estimation, S and SRD are treated as policy instruments in preference to the usual monetary aggregates such as the money supply or the cash base. The results of the analysis suggest considerable support for such an approach on three separate grounds: firstly, the reaction of the individual instruments assumes a different form; secondly, the costs of adjusting the two instruments are quite distinct, and finally, the choice of instruments obviously depends on the intention of the policy change and the two preceding factors.

In regard to the first point, it is apparent that there is an assignment of instruments between domestic and external policy. The SRD instrument is more closely associated with movements in the two domestic policy targets; unemployment and inflation. On the other hand, the securities instrument is more closely associated with movements in Australia's foreign reserves, particularly in regard to the problem of the impact of these on the supply of money. In fact, a significant 'sterilization' influence is observed. There is also an obvious cost of adjusting the securities instrument; an expansion of the money supply, brought about by a net purchase of securities, can only be achieved at the cost of higher interest rates.

The use of a shift-dummy approach to split the time period into monetary contraction and expansion reveals that there is also a negative cost associated with the contraction of the money supply; interest rates and the securities instrument are seen to be mutually associated even in contractionary phases. Hence, the use of the SRD instrument is preferable when an expansionary monetary policy is to be achieved, because no political costs (i.e. increased interest rates) are associated with this instrument.

The analysis also reveals the significance and importance of the 'sterilization' aspect of open market operations in times of monetary expansion as compared with monetary contraction. This presumably illustrates the policy maker's concern for the inflationary consequences of an increase in foreign reserves, and the impact of this on the cash base, during an expansionary phase.

The SRD instrument also varies between periods of monetary expansion and contraction. The instrument reacts strongly to the unemployment target in the expansionary phase, but not in the contractionary phase. This apparently reflects the higher priority given to unemployment when the policy intention is expansionary. There is some evidence of a policy reversal in a contractionary phase, as the inflation target is shown to be more important than the unemployment target. Neither target is highly significant during the contractionary period however.

There is considerable support for the disaggregated approach taken in the analysis. The concept of the money supply is apparently less useful in the context of an analysis of economic policy. In that case, it appears to be more practical to think of monetary policy in terms of disaggregated instruments such as the two instruments analysed here. In the light of these findings, it appears that little importance can be attached to previous reaction function studies which have ignored the principles set out in Waud's threefold analysis. These erroneously treat such aggregates, as the money supply or the cash base, as being *the* instruments of monetary policy.

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APPENDIX 5A

DATA

Year and Quarter	S ($m)	SRD (%)	U (%)
1961 (M)	1234.60	15.86	2.51
(J)	1013.30	14.44	3.39
(S)	875.00	12.26	4.08
(D)	818.80	11.71	3.50
1962 (M)	834.50	11.27	3.09
(J)	880.30	10.17	2.88
(S)	880.20	10.34	2.88
(D)	857.80	10.77	2.76
1963 (M)	787.00	10.38	2.54
(J)	718.60	11.03	2.46
(S)	714.40	10.44	2.19
(D)	648.30	9.99	1.94
1964 (M)	624.00	13.90	1.70
(J)	661.40	14.66	1.43
(S)	683.80	14.18	1.28
(D)	726.60	14.76	1.23
1965 (M)	731.30	14.33	1.16
(J)	846.00	13.12	1.16
(S)	861.60	13.80	1.23
(D)	862.70	12.13	1.48
1966 (M)	869.40	11.84	1.57
(J)	706.30	8.98	1.54
(S)	717.00	8.93	1.68
(D)	775.50	8.27	1.63
1967 (M)	775.50	8.13	1.66
(J)	823.90	8.50	1.75
(S)	893.10	8.40	1.73
(D)	873.20	8.16	1.68
1968 (M)	961.60	7.71	1.73
(J)	1028.80	7.56	1.65
(S)	1084.40	7.48	1.56
(D)	1129.10	8.31	1.59

Year and Quarter	S ($m)	SRD (%)	U (%)
1969 (M)	887.10	8.21	1.45
(J)	871.00	8.53	1.34
(S)	1115.40	8.85	1.30
(D)	1305.20	9.28	1.33
1970 (M)	1364.40	9.00	1.15
(J)	1227.70	9.65	1.19
(S)	1191.50	9.06	1.44
(D)	1181.00	8.69	1.34
1971 (M)	1140.60	8.58	1.46
(J)	978.60	8.25	1.55
(S)	779.60	7.94	1.86
(D)	723.00	7.72	2.01
1972 (M)	663.80	6.56	2.21
(J)	663.40	6.61	2.34
(S)	384.20	6.24	2.49
(D)	367.70	5.95	2.24
1973 (M)	794.10	6.05	1.86
(J)	658.10	6.99	1.92
(S)	665.80	7.98	1.75
(D)	673.50	8.27	1.83
1974 (M)	670.30	8.19	1.72
(J)	1276.50	7.98	1.74
(S)	1487.20	4.26	3.01
(D)	1175.40	2.72	4.84

Year and Quarter	$\dot{P}$ (%)	FR ($m)	R (%)
1961 (M)	4.31	822	5.46
(J)	3.20	1055	5.23
(S)	1.81	1134	4.59
(D)	0.78	1176	4.36
1962 (M)	-0.11	1132	4.39
(J)	-0.77	1140	4.30
(S)	-0.33	1180	4.25
(D)	0.11	1205	4.13
1963 (M)	0.33	1230	4.04
(J)	0.67	1292	3.75
(S)	0.66	1419	3.68
(D)	0.44	1634	3.64
1964 (M)	1.11	1721	3.63
(J)	1.66	1735	4.23
(S)	2.66	1765	4.35
(D)	3.99	1696	4.35
1965 (M)	3.96	1574	4.85
(J)	4.04	1441	4.95
(S)	3.88	1360	4.98
(D)	3.94	1368	4.96
1966 (M)	3.49	1417	4.98
(J)	3.36	1491	4.94
(S)	2.70	1464	4.96
(D)	2.36	1419	4.51
1967 (M)	2.56	1357	4.50
(J)	2.94	1340	4.52
(S)	3.94	1338	4.51
(D)	3.30	1310	4.71
1968 (M)	3.29	1323	4.86
(J)	2.86	1304	4.84
(S)	1.85	1334	4.83
(D)	2.62	1417	4.68

Year and Quarter	$\dot{P}$ (%)	FR ($m)	R (%)
1969 (M)	2.90	1529	4.78
(J)	2.87	1468	5.01
(S)	3.05	1350	5.27
(D)	2.83	1329	5.30
1970 (M)	3.19	1410	5.85
(J)	3.73	1594	6.32
(S)	3.80	1588	6.10
(D)	4.87	1632	6.00
1971 (M)	4.91	1971	6.07
(J)	5.39	2258	6.00
(S)	6.70	2595	5.95
(D)	7.19	2811	4.80
1972 (M)	7.11	3305	4.80
(J)	6.22	3691	4.58
(S)	5.69	4426	4.33
(D)	4.50	4814	4.67
1973 (M)	5.67	4425	4.65
(J)	8.19	4252	5.70
(S)	10.61	4111	7.70
(D)	13.23	4091	7.63
1974 (M)	13.57	3967	7.78
(J)	14.40	3560	10.10
(S)	16.04	3348	10.69
(D)	16.25	3217	8.13

Year and Quarter		SRD^e (%)	SRD^c (%)	S^e ($m)
1961	(M)	15.86	0	1234.60
	(J)	14.44	0	1013.30
	(S)	12.26	0	875.80
	(D)	11.71	0	818.80
1962	(M)	11.27	0	834.50
	(J)	10.17	0	888.30
	(S)	10.34	0	880.20
	(D)	10.77	0	857.80
1963	(M)	10.38	0	787.00
	(J)	11.03	0	718.60
	(S)	10.44	0	714.40
	(D)	9.94	0	648.30
1964	(M)	0	13.90	0
	(J)	0	14.66	0
	(S)	0	14.18	0
	(D)	0	14.76	0
1965	(M)	14.33	0	731.30
	(J)	13.12	0	846.00
	(S)	13.30	0	861.60
	(D)	12.13	0	862.70
1966	(M)	11.84	0	869.40
	(J)	8.98	0	706.30
	(S)	8.93	0	717.00
	(D)	8.27	0	775.50
1967	(M)	8.13	0	775.50
	(J)	8.50	0	823.90
	(S)	8.40	0	893.10
	(D)	8.16	0	873.20
1968	(M)	7.71	0	961.60
	(J)	7.56	0	1028.80
	(S)	7.48	0	1084.40
	(D)	8.31	0	1129.10

Year and Quarter	SRD^e (%)	SRD^c (%)	S^e (\$m)
1969 (M)	0	8.21	0
(J)	0	8.53	0
(S)	0	8.85	0
(D)	0	9.28	0
1970 (M)	0	9.00	0
(J)	0	9.65	0
(S)	0	9.06	0
(D)	8.69	0	1181.00
1971 (M)	8.58	0	1140.60
(J)	8.25	0	978.60
(S)	7.94	0	779.60
(D)	7.72	0	723.00
1972 (M)	6.56	0	663.80
(J)	6.61	0	663.40
(S)	6.24	0	383.20
(D)	5.95	0	368.70
1973 (M)	0	6.05	0
(J)	0	6.99	0
(S)	0	7.98	0
(D)	0	8.27	0
1974 (M)	0	8.19	0
(J)	7.98	0	1276.50
(S)	4.26	0	1487.20
(D)	2.72	0	1175.40

Year and Quarter	S^c (\$m)	U^e (%)	U^c (%)
1961 (M)	0	2.51	0
(J)	0	3.69	0
(S)	0	4.08	0
(D)	0	3.50	0
1962 (M)	0	3.09	0
(J)	0	2.88	0
(S)	0	2.88	0
(D)	0	2.76	0
1963 (M)	0	2.54	0
(J)	0	2.46	0
(S)	0	2.19	0
(D)	0	1.94	0
1964 (M)	624.00	0	1.70
(J)	661.40	0	1.43
(S)	683.80	0	1.28
(D)	726.60	0	1.23
1965 (M)	0	1.16	0
(J)	0	1.16	0
(S)	0	1.23	0
(D)	0	1.48	0
1966 (M)	0	1.57	0
(J)	0	1.54	0
(S)	0	1.68	0
(D)	0	1.63	0
1967 (M)	0	1.66	0
(J)	0	1.75	0
(S)	0	1.73	0
(D)	0	1.68	0
1968 (M)	0	1.73	0
(J)	0	1.65	0
(S)	0	1.56	0
(D)	0	1.59	0

Year and Quarter	S^c (\$m)	U^e (%)	U^c (%)
1969 (M)	887.10	0	1.45
(J)	871.00	0	1.34
(S)	1115.40	0	1.30
(D)	1305.20	0	1.33
1970 (M)	1364.40	0	1.15
(J)	1227.70	0	1.19
(S)	1191.50	0	1.44
(D)	0	1.34	0
1971 (M)	0	1.46	0
(J)	0	1.55	0
(S)	0	1.86	0
(D)	0	2.01	0
1972 (M)	0	2.21	0
(J)	0	2.34	0
(S)	0	2.49	0
(D)	0	2.24	0
1973 (M)	794.10	0	1.86
(J)	658.10	0	1.92
(S)	665.80	0	1.75
(D)	673.50	0	1.83
1974 (M)	670.30	0	1.72
(J)	0	1.74	0
(S)	0	3.01	0
(D)	0	4.84	0

Year and Quarter	$\dot{P}^e$ (%)	$\dot{P}^c$ (%)	FR^e ($m)
1961 (M)	4.31	0	822
(J)	3.20	0	1055
(S)	1.81	0	1134
(D)	0.78	0	1176
1962 (M)	-0.11	0	1132
(J)	-0.77	0	1140
(S)	-0.33	0	1180
(D)	0.11	0	1205
1963 (M)	0.33	0	1230
(J)	0.67	0	1292
(S)	0.66	0	1419
(D)	0.44	0	1634
1964 (M)	0	1.11	0
(J)	0	1.66	0
(S)	0	2.66	0
(D)	0	3.99	0
1965 (M)	3.96	0	1574
(J)	4.04	0	1441
(S)	3.88	0	1360
(D)	3.94	0	1368
1966 (M)	3.49	0	1417
(J)	3.36	0	1491
(S)	2.70	0	1464
(D)	2.36	0	1419
1967 (M)	2.56	0	1357
(J)	2.94	0	1340
(S)	3.94	0	1338
(D)	3.30	0	1310
1968 (M)	3.29	0	1323
(J)	2.86	0	1304
(S)	1.85	0	1334
(D)	2.62	0	1417

Year and Quarter	$\dot{P}^e$ (%)	$\dot{P}^c$ (%)	FR^e ($m)
1969 (M)	0	2.90	0
(J)	0	2.87	0
(S)	0	3.05	0
(D)	0	2.83	0
1970 (M)	0	3.19	0
(J)	0	3.73	0
(S)	0	3.80	0
(D)	4.87	0	1632
1971 (M)	4.91	0	1971
(J)	5.39	0	2258
(S)	6.70	0	2595
(D)	7.19	0	2611
1972 (M)	7.11	0	3305
(J)	6.22	0	3691
(S)	5.69	0	4426
(D)	4.50	0	4814
1973 (M)	0	5.60	0
(J)	0	8.19	0
(S)	0	10.61	0
(D)	0	13.23	0
1974 (M)	0	13.57	0
(J)	14.40	0	3560
(S)	16.04	0	3348
(D)	16.25	0	3217

Year and Quarter	FR^c ($m)	R^e (%)	R^c (%)
1961 (M)	0	5.46	0
(J)	0	5.23	0
(S)	0	4.59	0
(D)	0	4.36	0
1962 (M)	0	4.39	0
(J)	0	4.30	0
(S)	0	4.25	0
(D)	0	4.13	0
1963 (M)	0	4.04	0
(J)	0	3.75	0
(S)	0	3.68	0
(D)	0	3.64	0
1964 (M)	1721	0	3.63
(J)	1735	0	4.23
(S)	1765	0	4.35
(D)	1696	0	4.35
1965 (M)	0	4.85	0
(J)	0	4.95	0
(S)	0	4.98	0
(D)	0	4.96	0
1966 (M)	0	4.98	0
(J)	0	4.94	0
(S)	0	4.96	0
(D)	0	4.51	0
1967 (M)	0	4.50	0
(J)	0	4.52	0
(S)	0	4.51	0
(D)	0	4.71	0
1968 (M)	0	4.86	0
(J)	0	4.84	0
(S)	0	4.83	0
(D)	0	4.68	0

Year and Quarter	FR^c (\$m)	R^e (%)	R^c (%)
1969 (M)	1529	0	4.78
(J)	1468	0	5.01
(S)	1350	0	5.27
(D)	1329	0	5.30
1970 (M)	1410	0	5.85
(J)	1594	0	6.32
(S)	1588	0	6.10
(D)	0	6.00	0
1971 (M)	0	6.07	0
(J)	0	6.00	0
(S)	0	5.95	0
(D)	0	4.80	0
1972 (M)	0	4.80	0
(J)	0	4.58	0
(S)	0	4.33	0
(D)	0	4.67	0
1973 (M)	4425	0	4.65
(J)	4252	0	5.70
(S)	4111	0	7.70
(D)	4091	0	7.63
1974 (M)	3968	0	7.78
(J)	0	10.10	0
(S)	0	10.69	0
(D)	0	8.13	0

CHAPTER 6: STABILITY OF THE REACTION FUNCTIONS

The objective of this chapter is to test the fitted reaction equations for temporal stability. Christian [1] emphasises the importance of these tests as indicators of the policy maker's revision of the relative weights attached to the various policy targets. If the coefficients, in equations (5.3) and (5.4), prove to be constant through time, then we can accept that the relative weights attached to each target are invariant in different phases of the business cycle. The evidence adduced so far does not support this contention.
In Chapter 5, the regression coefficients were observed to vary with the policy intention. Thus, the revision of the relative weighting pattern at different points of the business cycle represents a major source of temporal instability in the reaction equations. The response of the SRD instrument will be to the domestic targets. The instability of the S-instrument may be explained by analysing its association with movements in the level of Australia's foreign reserves.

Tests for stability of the reaction functions are important also if the reaction functions themselves are to be integrated into a full scale econometric model. Temporally inconsistent parameter estimates for the functions will lead to untenable and misleading results, introducing a bias into the estimation of multiplier effects. Goldfeld and Blinder [4, pp. 631-2], in an evaluation of some of the conceptual problems involved, suggest that reaction patterns may alter because of changes in the official structure of the policy making administration in any one of three ways; the first is the argument outlined in the opening paragraph concerning the relative importance attached to each of the various targets of policy; secondly, the economic planning tools or models of the government or the policy makers may be altered or revised, and finally, any new relationship between various policy making bodies[1] may have an influence on the policy 'mix'.

In order to analyse the overall problem of stability in the estimated reaction functions, use is made of the TIMVAR program [3] which is used to fit an ordinary least squares regression model to time series data, and then to investigate the constancy of the regression over time. The theoretical framework of the TIMVAR technique is discussed in detail in section 6.1, and the various tests associated with the program are set out. Following this discussion, each of the reaction functions for S and SRD are subjected to the various tests. From these tests it is possible to observe firstly whether the functions are stable or unstable over time, and secondly the actual points at which any changes occur in the stability of these functions. From this analysis, any unstable periods will be isolated and an attempt made to explain the inherent instability.

6.1 The theoretical framework of the TIMVAR technique

The validity of the assumption that any regression relationship is constant over time is dubious. Because of this, it is necessary to examine the statistical constancy of any estimated relationship. Previous attempts at analysing stability problems have concentrated on

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1. For example, in Australia, the relationship between the Government, as represented by Treasury, and the Reserve Bank.

the splitting of periods and the application of the Chow test [2], or the use of dummy variables [5, pp. 409-30]. This results in an *ad hoc* splitting of the sample period and the possibility that the structural change may not be detected. One of the more general techniques now available is the TIMVAR program which provides a method of testing the stability properties of any estimated relationship by the use of printed and graphical output.

The theoretical framework of the TIMVAR technique is based on a regression model which can be written as:

$$y_t = \underset{\sim}{x}_t' \underset{\sim}{\beta}_t + \mu_t$$

where $t = 1 \ldots T$

and $\underset{\sim}{x}_t$ = the column vector of observations at each of these time periods, on each of the k regressors

$\underset{\sim}{\beta}_t$ = the vector of regression coefficients

μ_t = $\mu_1 \ldots \mu_T$ are the independent normal variables, with an assumed mean of zero, and variances of $\sigma_1^2 \ldots \sigma_\tau^2$.

The various statistical tests defined in the TIMVAR technique are based on the assumption that the variances are constant over time, and that the null hypothesis is

$$H_0 : \underset{\sim}{\beta}_1 = \ldots\ldots\ \underset{\sim}{\beta}_\tau$$

The TIMVAR technique makes use of the recursive residuals, defined as follows:

$$w_r = \frac{y_r - \underset{\sim}{x}_r' \underset{\sim}{b}_{r-1}}{\sqrt{1 + \underset{\sim}{x}_r'(\underset{\sim}{X}_{r-1}'\underset{\sim}{X}_{r-1})^{-1}\underset{\sim}{x}_r}}$$

where r = k+1, ..., T.

Any changes in the means of the w_r's imply departures from the null hypothesis, H_0, of constancy in the regression coefficients.

The first test of significance is the cumulative sums or *cusum test* which is one means of testing the null hypothesis, H_0. In this experiment, H_0 is tested by plotting the cumulative sum of the recursive residuals (W_r), where this cusum plot is defined as

$$W_r = \frac{1}{s} \sum_{j=k+1}^{r} w_j$$

and s is the mean square residual.

This statistic is then tested to see whether it differs significantly from its expected value of zero. If W_r is significant, then H_0 is rejected and instability is generally indicated. This arises when prediction errors are consistently positive or negative over a large part of the sample period. Such instability is detected from the graphical output of the cusum test and is represented by continually large movements in W_r.

The second major test for the stability of the specified regression relationship is the cumulative sum of recursive residuals squared, or *cusum of squares* test. This test is based on a plot of the following, over time:

$$S_r = \frac{\sum_{j=k+1}^{r} w_j^2}{\sum_{j=k+1}^{T} w_j^2}$$

where r = k+1, ..., T.

Like the cusum test, the cusum of squares test involves the sum of the recursive one period prediction errors. However in this case, the errors are squared and the test statistic is always positive ($S_r > 0$). This test is used to determine whether the errors are evenly distributed throughout the sample period. H_0 is rejected and instability indicated, if S_r is significant at a selected significance level. This occurs if the cusum squares plot shows wide variation.

A final test for the stability of the specified regression is the *homogeneity test*. This test statistic is derived as a generalization of the Chow test, using the analysis of variance for p equal-sized non overlapping periods. The homogeneity test is derived by comparing it with the standard tables of the F-distribution.

In those cases where the above-mentioned tests reject the null hypothesis, it is worthwhile to attempt to detect the point or points of change. This is made possible by means of *Quandt's Log Likelihood Ratio* which is useful for detecting abrupt changes in a regression relationship at an unknown time. No statistical test of significance is associated with Quandt's test, and so its use is simply confined to the identification of the timing of any structural changes in the estimated relationship.

In the TIMVAR output, the printout of both the backward and the forward recursions are made available. Since the backward recursions are the less important, and also because they tend to reinforce the findings of the forward recursions, only the latter results are analysed in detail. All recursions relate to a 28-period moving average.

6.2 Stability of the SRD function

6.2.1 The formal tests

The value of the cusum test statistic (W_r), as specified for the SRD equation, is 1.55740. This value must be compared with the following:

1.143 for one percent level of significance

0.948 for five percent level of significance

0.850 for ten percent level of significance.

Since the output value of 1.55740 is greater than all these standard significance levels, the null hypothesis is rejected, and it is concluded that the SRD function has a 99 percent chance of being unstable.

The *cusum of squares test* reinforces the earlier finding. In order to determine whether the cusum of squares test is significant for a particular level of significance, the test statistic produced by the TIMVAR output is compared with a test statistic which is taken from a specially prepared table.[2] The TIMVAR output from the SRD equation provides a value of 0.210976 for the cusum of squares test. This value of S_r is compared with the value drawn from the table in Appendix 6B which is entered at row $n = \frac{1}{2}(T - k)$, where T is the number of observations and k is the number of regressors. The values for the one, five and ten percent levels of significance are given as follows:

0.28951 for the one percent level of significance

0.23835 for the five percent level of significance

0.21268 for the ten percent level of significance.

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2. See Appendix 6B.

The *homogeneity statistic* produced in the TIMVAR output is compared with the standard tables of the F-distribution for 6 and 44 degrees of freedom. The value of 3.24 for the one percent level of significance and the value of 2.31 for the 5 percent level of significance is shown in the table. Both of these values are less than the value of 10.5363 given by the TIMVAR output and, hence, provide additional evidence that the SRD regression is unstable at both the 1 percent and the 5 percent levels.

All three tests described above produce a similar result in regard to the SRD equation; instability is evident at all major levels of significance. It remains, however, to determine those periods which have contributed to this inherent instability.

6.2.2 A graphical analysis of SRD stability. Identification of periods of instability

The TIMVAR program provides a method of graphically analysing and detecting the actual periods of instability in the estimated function. Figures 6(a) and 6(b) in Appendix 6A plot the cusum and cusum of squares tests for the SRD function. An examination of the plots for the cusum test indicates that the instability in the SRD function is fairly extensive. The unstable periods can be detected from the plots as being those in which considerable variation occurs in the plotted value of the cusum and cusum of squares statistics. In particular, several large periods of instability can be detected from Figure 6(a):

(i) observations 20-33, corresponding to the period 1965(4) - 1969(1)

(ii) observations 39-43, corresponding to the period 1970(3) - 1971(3)

(iii) observations 48-50, corresponding to the period 1972(4) - 1973(2).

The cusum of squares test, as graphed in Figure 6(b), reinforces the periods of instability observed in the plot of the cusum test. In fact, the periods coincide almost identically, except that no instability is observed in periods 48-50 according to the cusum of squares test.

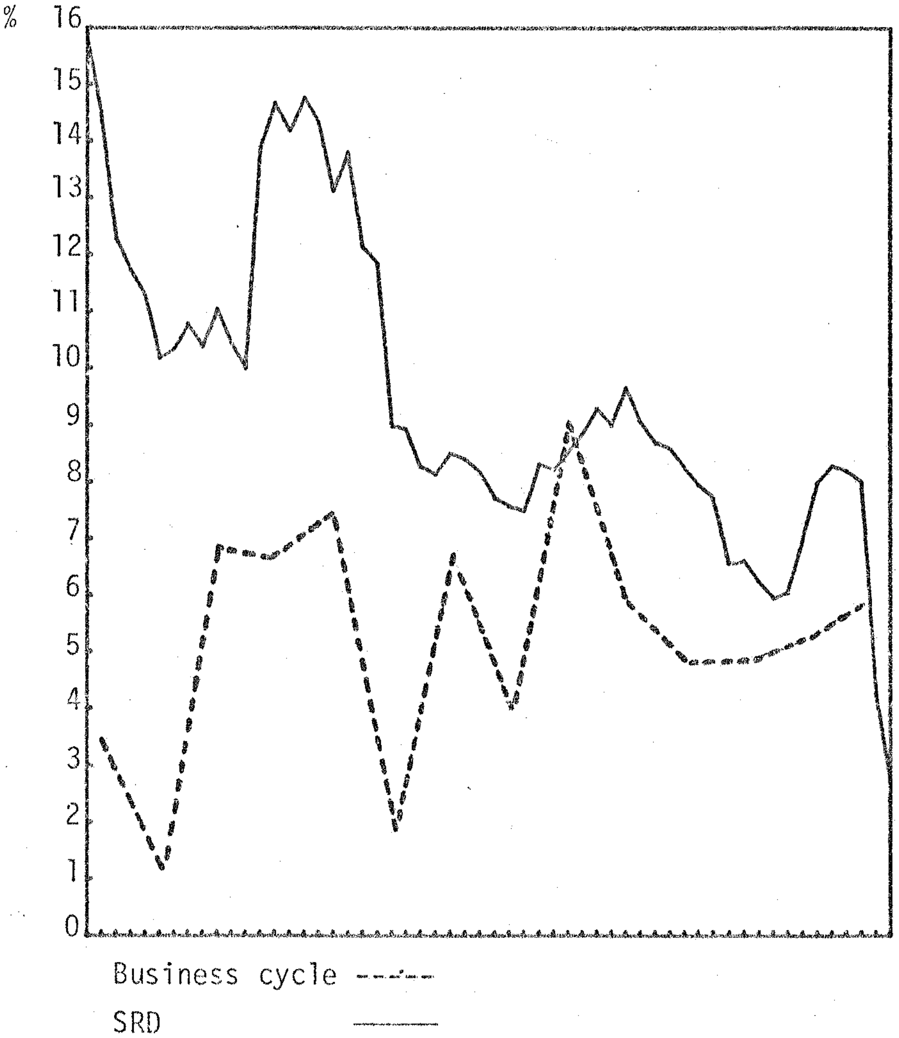
One further test of the accuracy in recording these observed periods of instability is achieved by reference to Quandt's Log Likelihood Ratio which is plotted in Figure 6(c) in Appendix 6A. This test reinforces the timing of the unstable periods observed in the cusum and cusum of squares plots. However, an additional unstable period, given by observations 11-19, is noted. These observations correspond to the time period 1963(3) - 1965(3).

6.2.3 Relationship between the instability of the SRD instrument and the business cycle

Goldfeld and Blinder [4, pp. 631-2] suggest that changes in the reaction pattern of the policy making authorities may be brought about by changes in the relative weights attached to each alternative target of policy. These changes in relative weights are brought about by a change in, or re-emphasis on, one target of policy over another. If the policy maker operates an active counter-cyclical policy, then the revision of policy weights may be associated with turning points in the business cycle. Such action necessitates the use of a contractionary monetary policy during an upswing in the cycle and an expansionary policy in the downswing. Thus, the policy maker's intention is most likely to be revised at, or near, the turning points in the business cycle. As the SRD instrument responds to the domestic targets - inflation and unemployment - instability in the SRD equation may be explained by the changed policy intention occurring at peaks and troughs of the cycle. This proposition may be analysed by comparing periods of instability in the SRD equation with the business cycle.

The cyclical variation in activity, as represented by the time plot of the real rate of growth in output ($\frac{\Delta GNP}{GNP_{-1}}$ %), is given in Figure 6(1) by the broken line. The SRD ratio is plotted for the same period. A comparison of these time paths is revealing. The cyclical variation of the economy is apparent. For example, there is a downswing in 1961 to the recession of that period. The SRD ratio shows a concomitant decline in this period, indicating an easing of credit market conditions. However, the lateness of the application of the SRD instrument in the recovery of 1962-63 is apparent. SRD policy follows a confused marginal pattern in the same period; the increases in the SRD are only small and are followed closely by small reductions. The large increase in the SRD ratio in early 1964 precedes the downswing in economic activity occurring in June 1965. The SRD instrument has an expansionary purpose during this latter period as it is reduced substantially. Such a policy has the desired stabilizing effect in this period, unlike the events of 1962-63 which appear to be a case of 'too little too late'.

Figure 6(1)
Fluctuations in the business cycle
and the SRD ratio 1961-1974



In the recovery of 1966-67, the SRD instrument shows a variable movement. It is increased for some time as the economy recovers from the trough of 1966, but is then gradually reduced in order to stimulate the upswing. In the 1967-68 downswing, the SRD ratio is reduced and, as a result, it has its desired stabilizing effect. The recovery from this 1967-68 trough evokes a lagged increase in the SRD instrument so that it peaks almost a year *after* the new peak in economic activity. The downswing in 1969-70 is exacerbated by initial concomitant increases in the SRD ratio. This policy is finally corrected in late 1970 and has the desired stabilizing effect over the period to June 1972. It appears that, in general terms, the SRD instrument reacts to cyclical variations in output. This means that the instrument is used as a counter-cyclical tool during these periods, although the timing of the policy change (1962-63, 1967-68) is sometimes inappropriate, and produces potentially destabilizing effects in the economy.

The association of the SRD instrument and the business cycle is less clear in the period 1972-74. This may be attributed to the change in policy attitudes of the Whitlam Government which, at first, opted for a tight monetary policy to offset the inflationary effects of their expenditure policies. The SRD is increased in 1973; such an action is not inconsistent with the gentle upswing in economic activity in the same period. However, the sharp reversal of this contractionary policy after June 1974 does *not* appear to have been initiated by the cyclical variation in economic activity.

The SRD instrument appears to follow movements in the business cycle until June 1974. This may explain the instability of the SRD function in the time series considered. The first period of instability, indicated *only* by the Quandt Log Likelihood Ratio test, is the period 1963(3) - 1965(3). From Figure 6(1) it is noted that only a small trough in activity occurs. The slackening in activity occurs before the confirmation of a peak level of growth which begins to turn down, after 1965, into a mild recession.

The second period of instability, indicated by the various timvar tests, extends from 1965(4) to 1969(1). In this period, the economy experiences two complete cycles; 1965-67 and 1967-69. The instability in the SRD function may be attributed to these cyclical movements for the reasons advanced earlier. The weights attached to the inflation and unemployment targets differ between the upswing and downswing, and, consequently, they are revised at some time near the turning points of the cycle - June 1966, June 1967 and June 1968. Some slight instability occurs in the SRD function in the period 1970(3) - 1971(3). This coincides with a slight variation in the downswing of the cycle which occurs in June 1970 and flattens out in June 1971.

The SRD function exhibits *stability* during the period 1971(4) to 1972(3). This occurs at a time when the variation in the business cycle is only slight. Such an observation provides further evidence to support the claim that the SRD instrument is used in a counter cyclical manner. Thus, the instability of equation (5.4) is due to cyclical variation with the associated revision of weights on the policy targets.

The last period of instability corresponds to the period 1972(4) - 1973(2). This instability cannot be explained by reference to Figure 6(1), as the association between the two paths changes drastically. During this period, the unpredictable economic climate and the difficulty in interpreting the various economic indicators [6, p. 77] generally confused the overall direction of policy. The instability of the SRD function is the end result of this generally confused economic situation.

6.3 Stability of the securities function

6.3.1 The formal tests

The value of the *cusum test* as specified by the TIMVAR output is 1.00976. When compared to the three standard values mentioned previously, it is obvious that the function is unstable at the 5 percent level of significance. The null hypothesis H_0 is thus rejected and it is concluded that the S-function has a 95 percent chance of being unstable.

The TIMVAR output prescribes the *cusum of squares test* statistic for the S-function as 0.396816, which, when compared with the table of statistics, implies a 1 percent level of significance. The null hypothesis is again rejected and it is concluded that the S-function exhibits an inherent instability.

The *homogeneity* statistic produced from the TIMVAR output for the securities equation is 7.80674. Comparing this with the standard tables of the F-distribution for 6 and 44 degrees of freedom, shows again that the S-function is unstable at both the 1 percent and the 5 percent levels.

6.3.2 A graphical analysis of S stability. Identification of periods of instability

Figures 6(d) and 6(e) in Appendix 6A illustrate the cusum and cusum of squares tests for the S-equation.

An examination of the cusum test graph indicates that several large periods of instability exist:

(i) observations 28-36, corresponding to the period 1967(4) - 1969(4).

(ii) observations 40-45, corresponding to the period 1970(4) - 1972(1)

(iii) observations 49-56, corresponding to the period 1973(1) - 1974(4).

The cusum of squares test again reinforces the findings of the cusum test, except that no large-scale instability is found in 1974(1) - 1974(4).

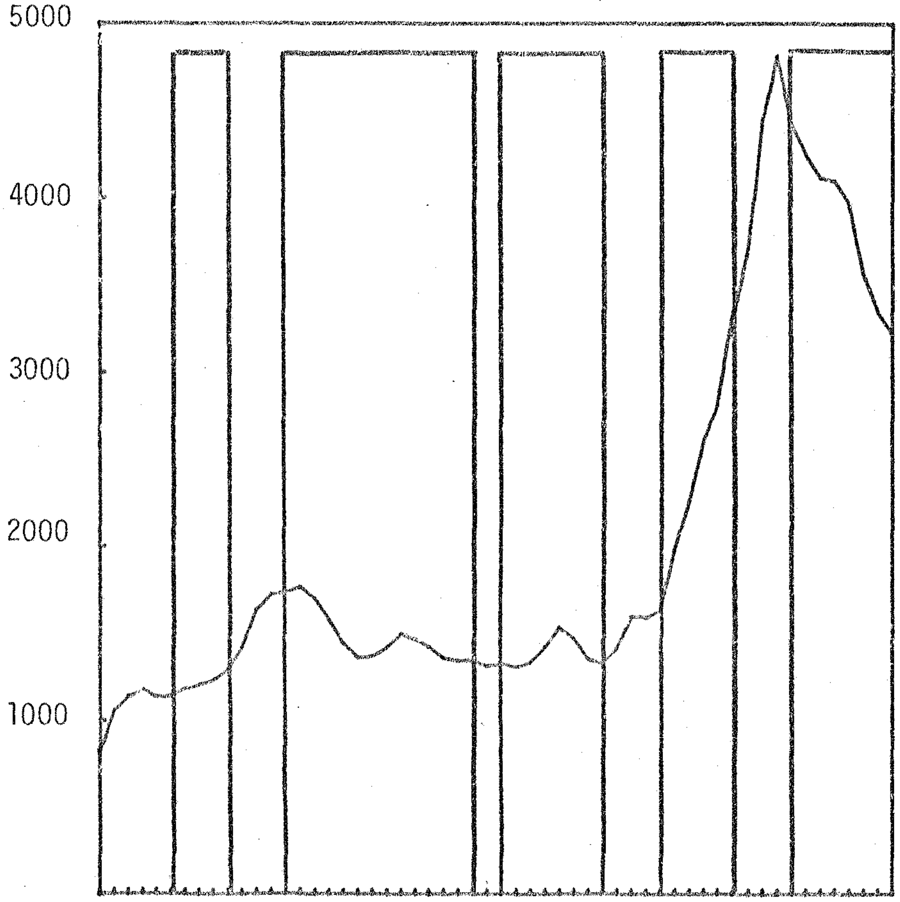
The Quandt test, illustrated in Figure 6(f), also reinforces the timing of the unstable periods as found by the cusum and cusum of squares tests. Additional periods of instability, also detected by this test, are given by observations 6-10 and 14-27, corresponding to the period 1962(2) - 1963(2) and 1964(2) - 1967(3).

6.3.3 Relationship between the instability of the S-instrument and the external situation

The analysis of equations (5.3) and (5.4) demonstrates an assignment of the two monetary policy instruments between internal and external balance. The analysis of the unstable periods for the S-equation is therefore carried out in terms of movements in the level of Australia's foreign reserves. Such an approach is necessary because of the failure of the securities instrument to respond to either of the two domestic targets; inflation and unemployment. Thus, movements in the business cycle will fail to explain the instability of this particular instrument.

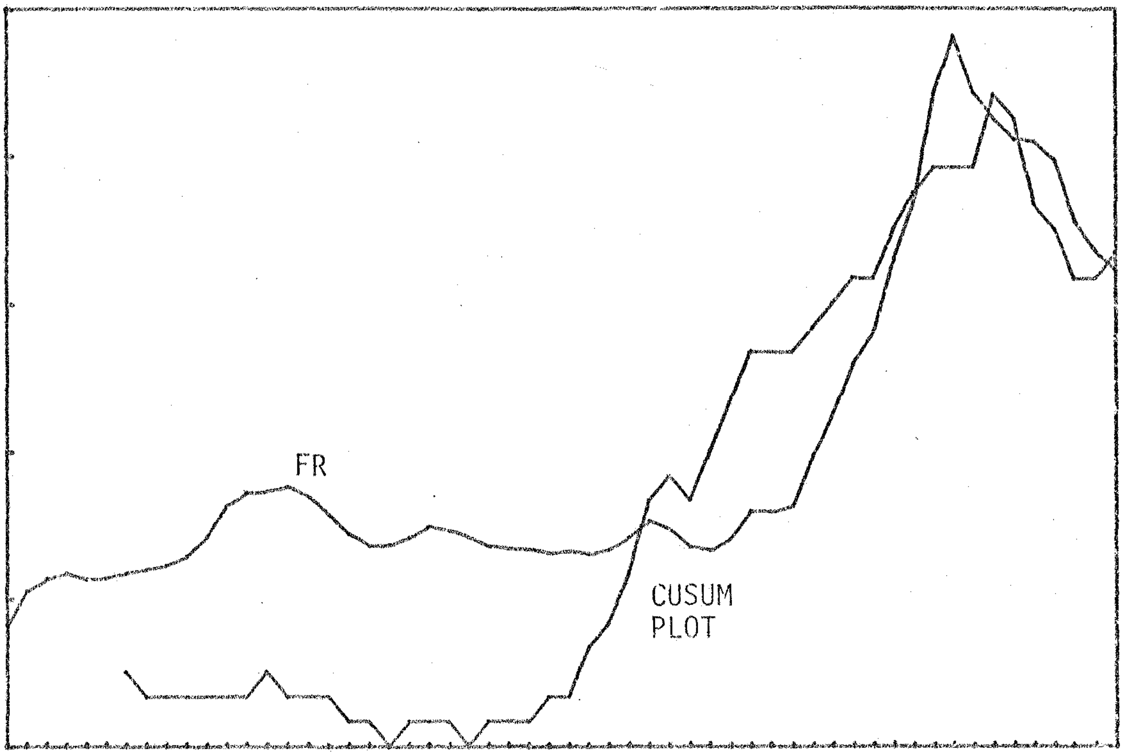
Figure 6(2) plots the level of Australia's foreign reserves from 1961 - 1974, with the major periods of instability, in the S-equation,

Figure 6(2)
Level of Australia's foreign reserves
and periods of instability
1961-1974 $m



marked. The most interesting observation in this regard is the closeness of the movement in the plotted cusum test for S and the level of reserves. Figure 6(3) plots the level of reserves and the cusum test simultaneously. Ignoring the small variations in the cusum plot, it is evident that the major instability in the S-function coincides closely with periods during which the level of reserves rose sharply. Several small periods of stability, as noted by the cusum plot, are seen to coincide with those quarters in which the

Figure 6(3)
Level of Australia's foreign reserves
and the plotted cusum test 1961-1974



level of reserves remain steady. Even after the beginning of the strongly unstable period (from 1967(4) onwards) there is evidence of a close association between the movement in reserves and the cusum plot. The period 1970(2) - 1970(4) is an example of this close association. One further point of interest from Figure 6(3) is the period of stability, as represented by the cusum plot, which occurs prior to, and after, the revaluation of December 1972.

From the end of 1970 to the end of 1972 the level of foreign reserves rose rapidly. At least part of this period of external surplus falls within those periods in which the S-equation is unstable. During 1970(4) - 1972(1), there was pressure on the exchange rate but the level of reserves was allowed to increase. Even though sharply rising import prices were contributing to an acceleration of cost-push inflation, the appropriate action - an appreciation of the exchange rate - was delayed. The majority of capital inflow during this period, which increased the level of foreign reserves, was only temporary and speculative [6, p. 69]. It had the adverse effect of bringing about a high rate of growth in the money supply. The instability of the S-equation during this period is an obvious result of the increased importance of the 'sterilization' policy of open market operations noted in equation (5.3).

The other period of instability which corresponds closely, in terms of the cusum test and the level of foreign reserves, is the period 1973(1) - 1974(4). This period itself is characterized by a continuing decline in the level of reserves, due to the December 1972 revaluation of the Australian dollar. Once again, the change in the weight of the foreign reserves variable in the S-equation is observed with the resultant instability showing up in the cusum and Quandt Log Likelihood tests.

6.4 Stability of Individual Targets

6.4.1 Unemployment and inflation

The most noticeable aspect of the analysis of the stability of individual targets is the stability of the unemployment target during 1968(4) - 1970(3). This period has been discussed by Perkins [6, p. 60], who suggests that during 1968-69, both budgetary and monetary measures were successful in maintaining full employment without serious inflation. The inflation target in the SRD equation (see Figure 6(h)) remains basically stable for some of this period, although there is some instability towards the end. This instability possibly results from the policy maker's concern, during 1969-70, that excess demand was increasing too rapidly. The unemployment target in the SRD equation is also stable for the period 1971(4) - 1974(2) (see Figure 6(g)). During the earlier part of this period, a considerable amount of expansion was taking place in an effort to stimulate the economy which was suffering from a high level of unemployment. On the other hand, the inflation target in the SRD equation does not display the same degree of stability until the end of 1973 when the rate of inflation increased rapidly. From this time onwards, *both* targets display a degree of stability in terms of the plotted stability tests.

6.4.2 Foreign reserves

Two important periods of stability are observed for this target: 1966(2) - 1968(3) and 1969(1) - 1969(4). These are shown in Figure 6(i). Although the foreign reserves target, according to Figure 6(i), exhibits strong stability for the period 1973(1) - 1974(4), this period must be ignored. The plotting of this 'stability' suggests that, if the scale were extended, the period would be classified as extremely unstable. These stable periods coincide with periods when the level of Australia's foreign reserves remained reasonably constant.

Normal 'sterilization' actions were carried out using open market operations which were easily borne by the money market. These periods of stability contrast sharply with the obvious instability which occurs during those periods epitomized by either rapidly rising or rapidly falling reserves. These findings support the original conclusions gleaned from Figure 6(3).

6.4.3 Interest rate

It is interesting to note from Figure 6(j) that the interest rate only exhibits a degree of stability from about 1971 onwards. In particular, three obvious stable periods are observed

(i) 1971(1) - 1971(3)

(ii) 1972(1) - 1973(1)

(iii) 1973(3) - 1974(3).

Although it is not possible to specify the reasons for this stability, the periods tabulated correspond closely with the periods in which the monetary authorities were prepared to allow interest rates to alter, or to allow open market operations to influence the market rate of interest. The earlier periods, which exhibit a strong instability, naturally correspond to those periods in which the lack of development of the capital market prevented the use of open market operations to any great extent.

6.5 Stability of interdependent instruments

It is also important to examine the periods of stability and instability in the relationship between SRD and S instruments. This test refers to the stability of the SRD instrument when it is included in the S-equation and *vice versa*. Figures 6(k) and 6(l) illustrate the stability problem in these cases. It is obvious that the period 1969(1) - 1974(4) is one characterized by a stable relationship between SRD and S and also S and SRD. Equations (5.3) and (5.4) indicate an 'harmonious' relationship between SRD and S, whereby changes in SRD policy induce open market operations to reinforce the original SRD change. This harmonious relationship is observed in Figure 6(k) where there is greater stability over the entire time period when the SRD instrument is included in the S-equation. Figure 6(l), on the other hand, indicates a general instability in all periods before 1969. There is evidence of a small period of stability from early 1963 to the end of 1964 illustrated by Figure 6(l). This period of stability does not show up in Figure 6(k).

6.6 Summary

The two reaction functions (5.3) and (5.4) are subjected to a detailed stability analysis by the use of the TIMVAR program. It is concluded that the two functions are inherently unstable over the period of estimation. The various periods of stability and instability are then analysed. For the internal instrument, the SRD ratio, the analysis is carried out with reference to the business cycle. It is found that the instability of the SRD function is consistent with the operation of a countercyclical economic policy which serves to alter the weights attached to each internal target. The weights change according to whether the business cycle has reached the peak or trough. These results are complemented by an analysis of the stability of the individual targets, U and $\dot{P}$. This analysis reveals a period of stability for the unemployment target which corresponds to a period of 'correct' budgetary and monetary management. The inflation target is also basically stable for this same period, although instability emerges towards the end of the period as the policy makers become more concerned about rising prices resulting from excess demand during 1969-70.

The analysis of the external instrument, S, is carried out with reference to movements in the level of foreign reserves. The main conclusion, once again, is that the S-equation is unstable for the majority of the time period examined. The shape of the cusum test plot, indicating great instability, corresponds almost identically to the large increase in reserves which begins at the end of 1970 and continues through the decline in reserves after 1972. The interest rate target exhibits a stable relationship with the open market instrument only after 1971. This result reflects the limited use of open market operations in influencing market determined rates of interest, especially during the earlier period from 1961-1970.

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APPENDIX 6A

GRAPHICAL STABILITY TESTS

Figure 6(a)
SRD CUSUM TEST

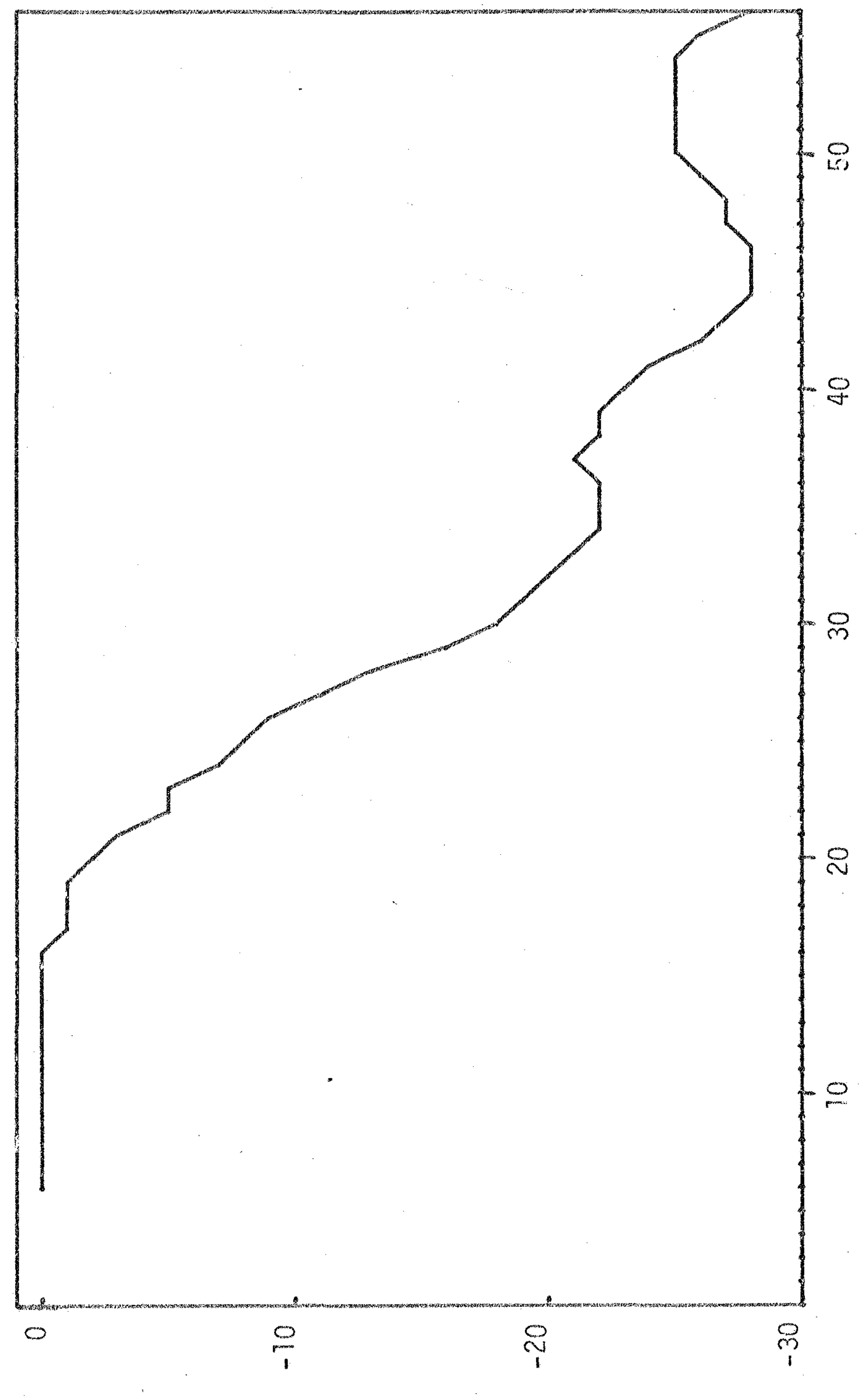


Figure 6(b)
SRD CUSUM OF SQUARES TEST

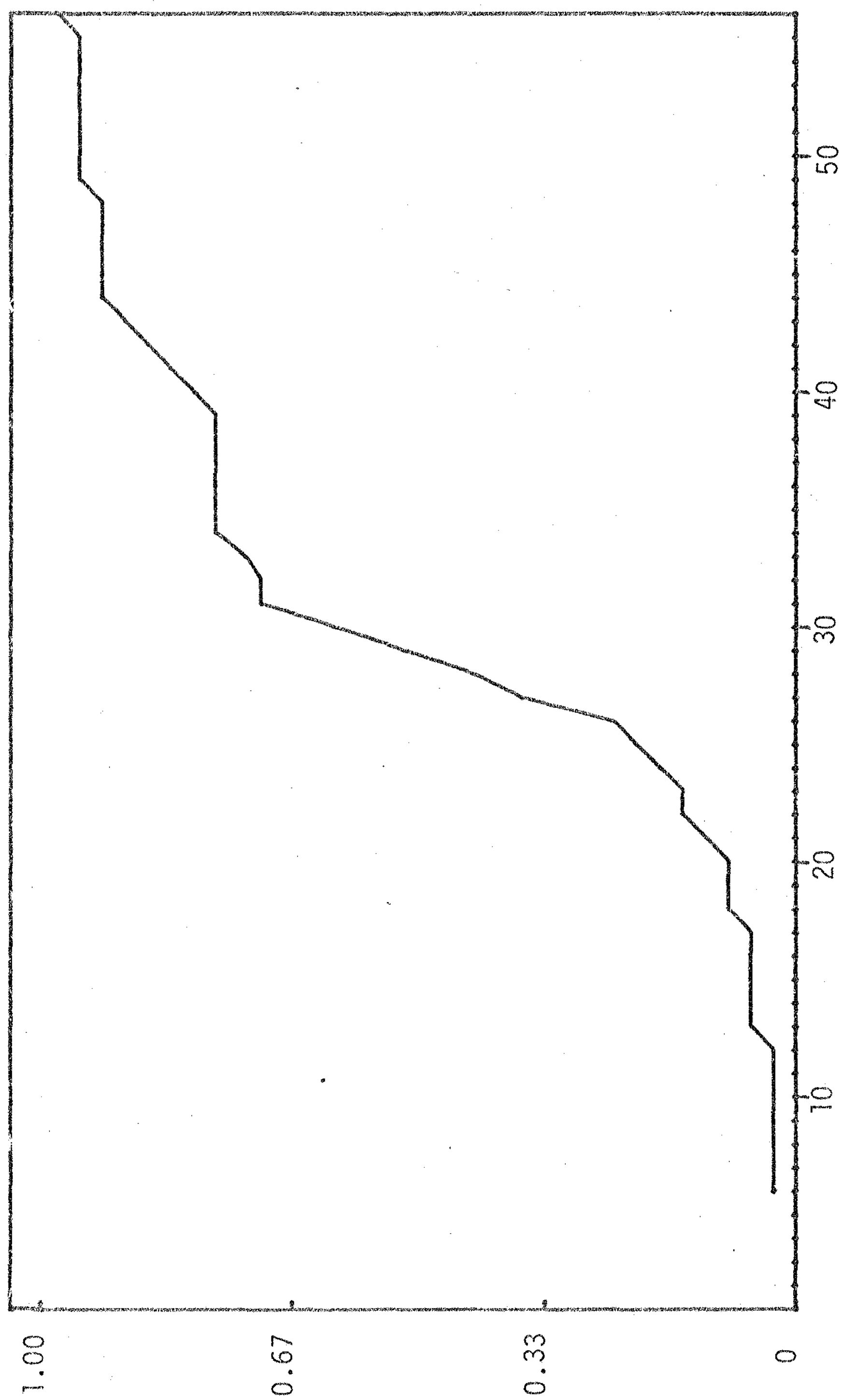


Figure 6(c)
QUANDT'S LOG LIKELIHOOD RATIO TEST
SRD

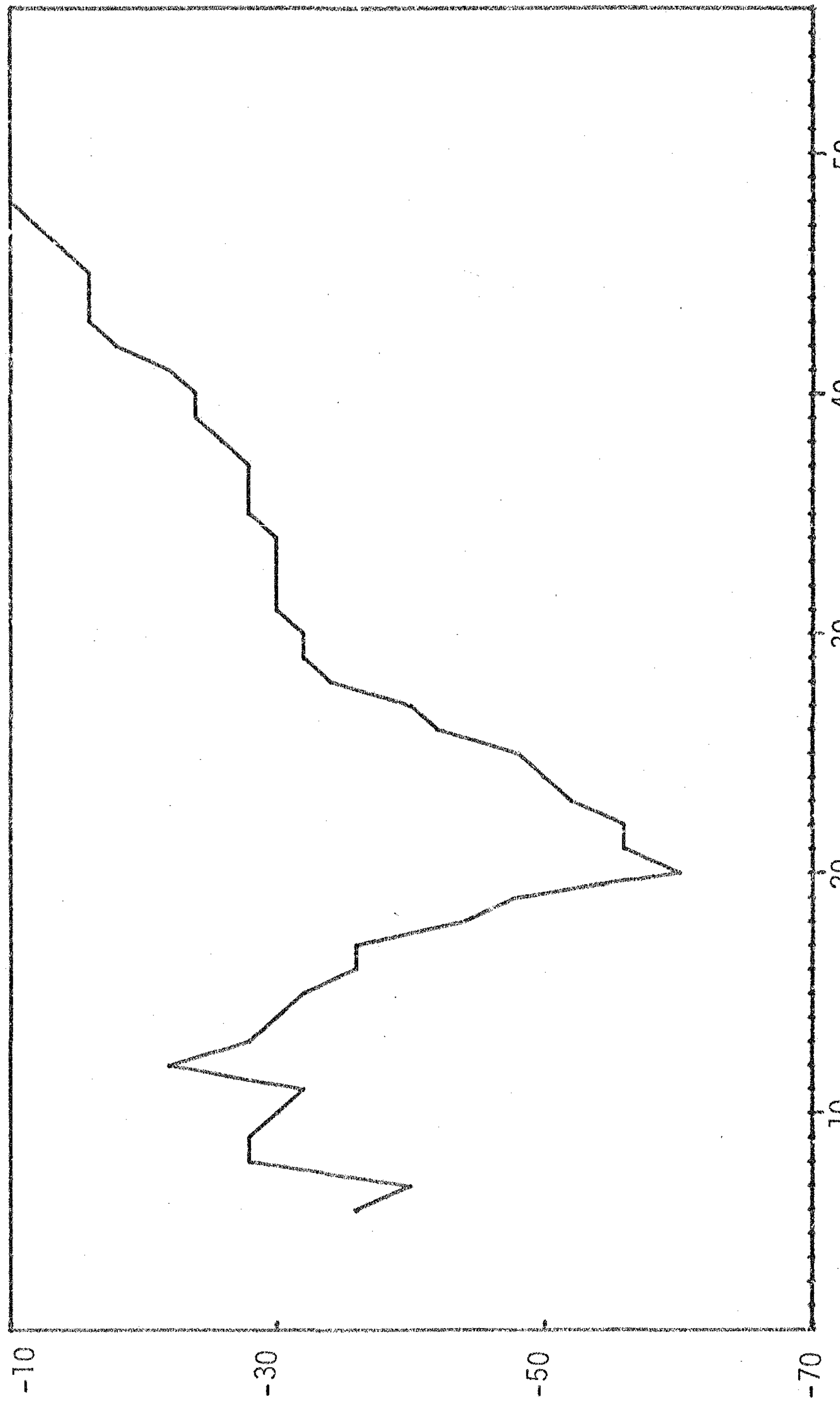


Figure 6(d)
S CUSUM TEST

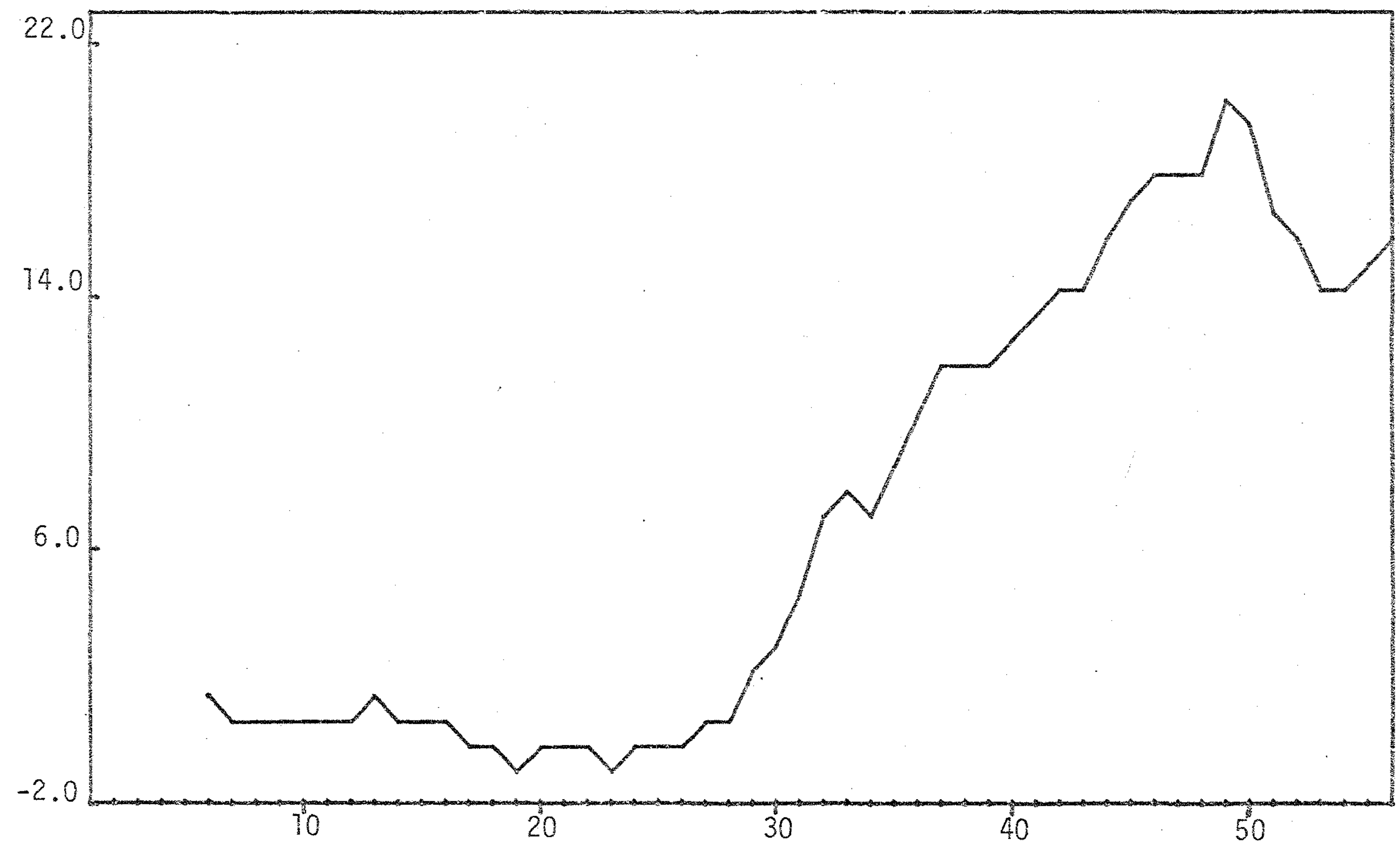


Figure 6(e)

S CUSUM OF SQUARES TEST

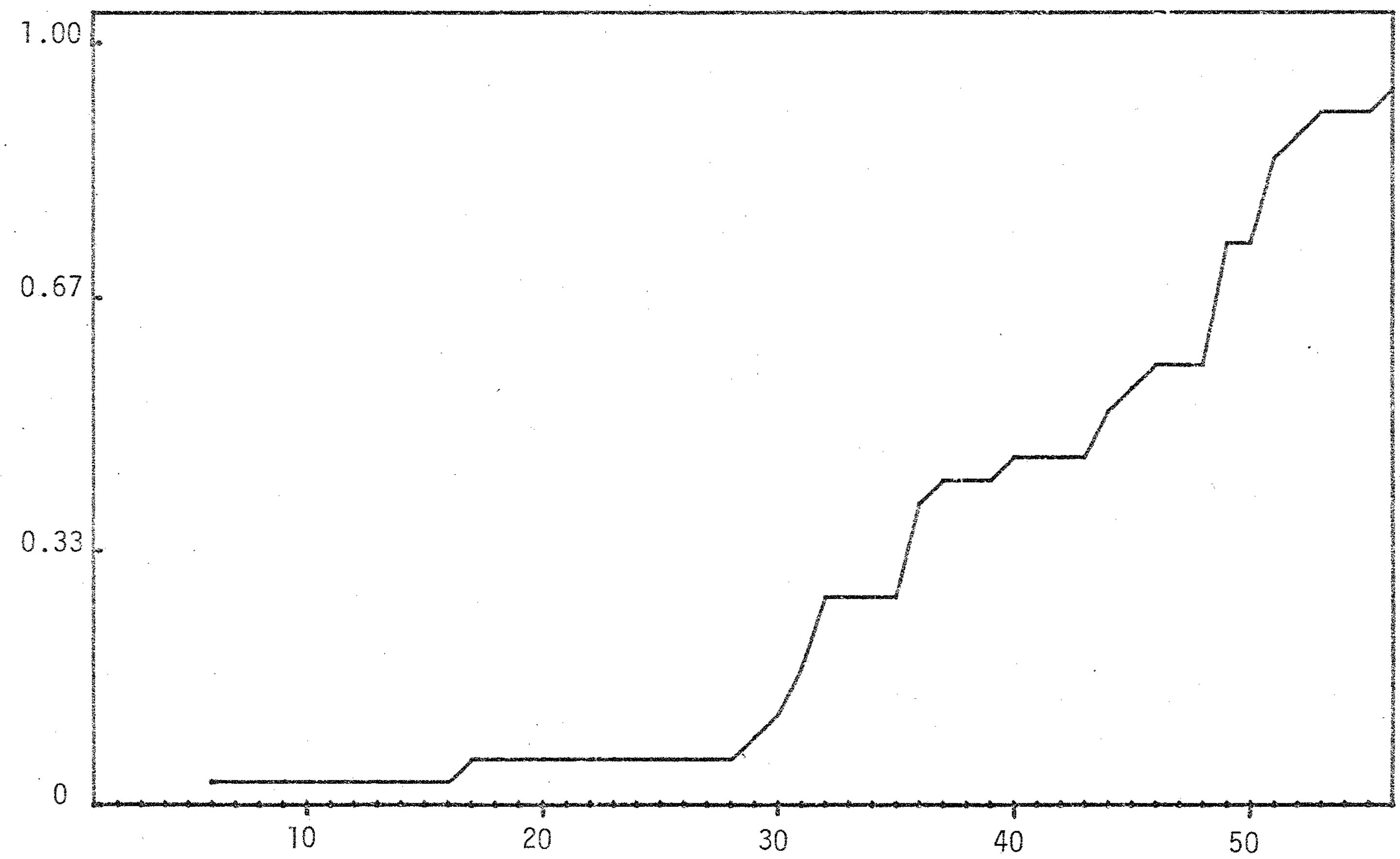


Figure 6(f)

QUANDT'S LOG LIKELIHOOD RATIO TEST

S

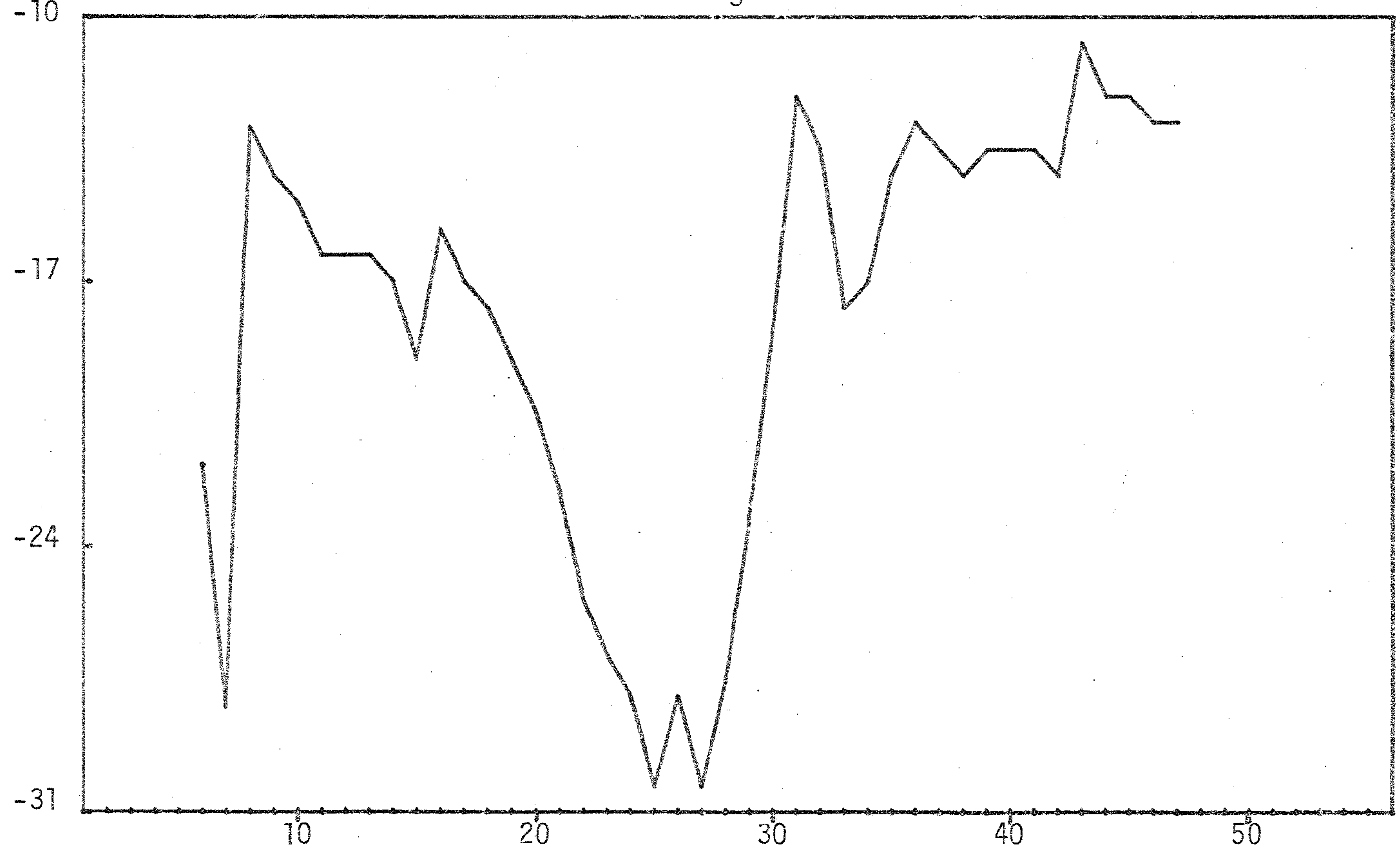


Figure 6(g)
STABILITY OF U

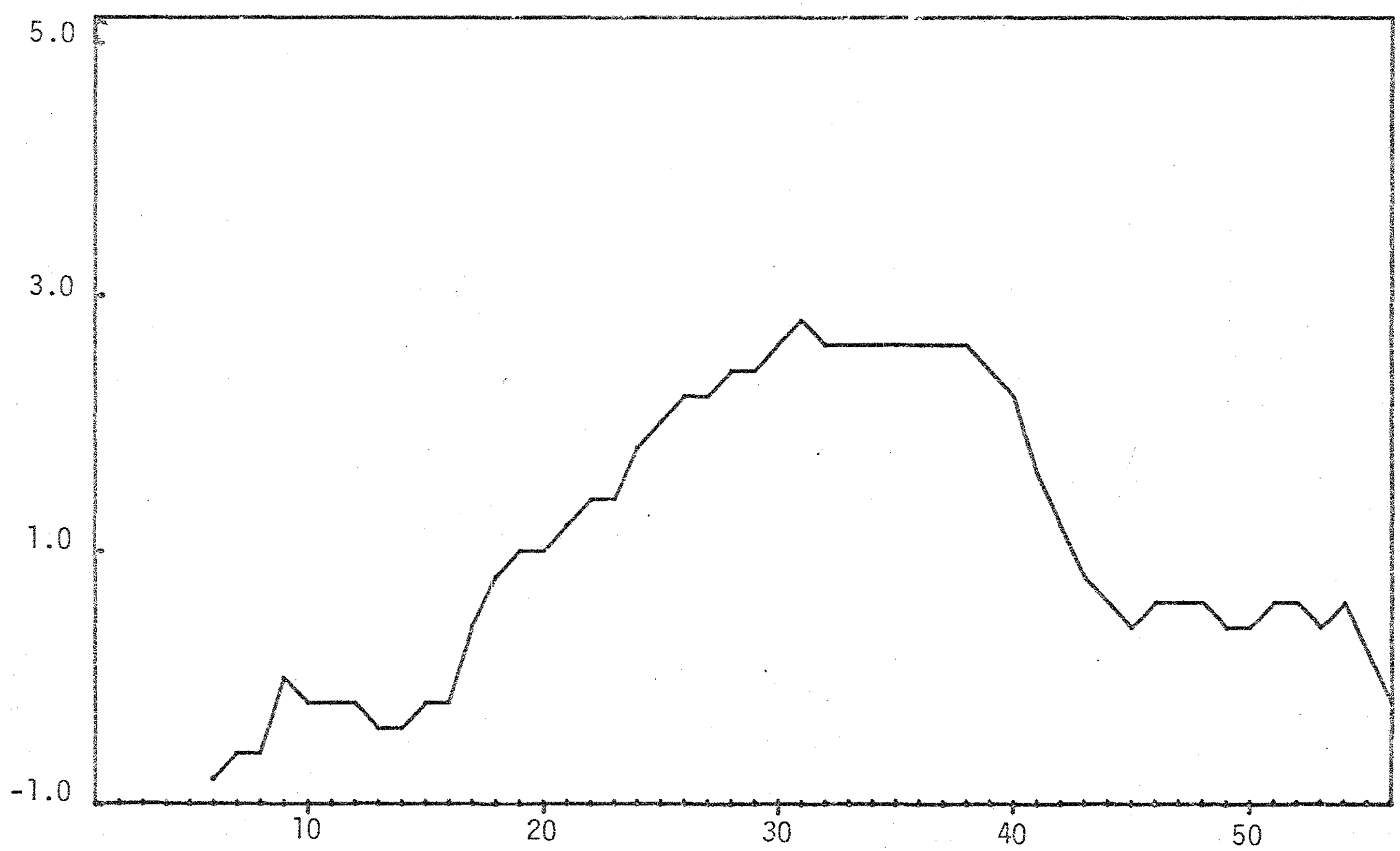


Figure 6(h)
STABILITY OF $\dot{P}$

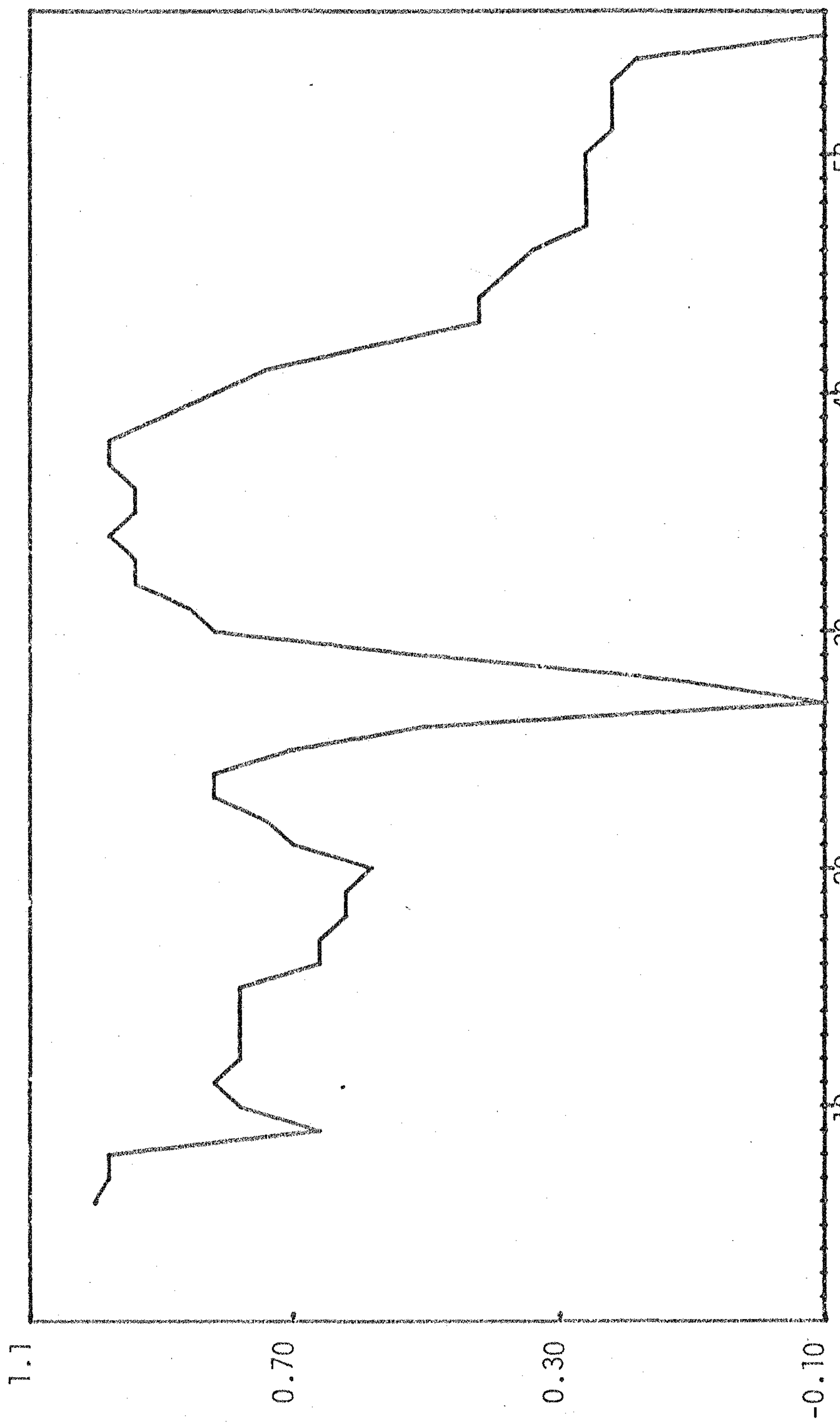


Figure 6(i)
STABILITY OF FR

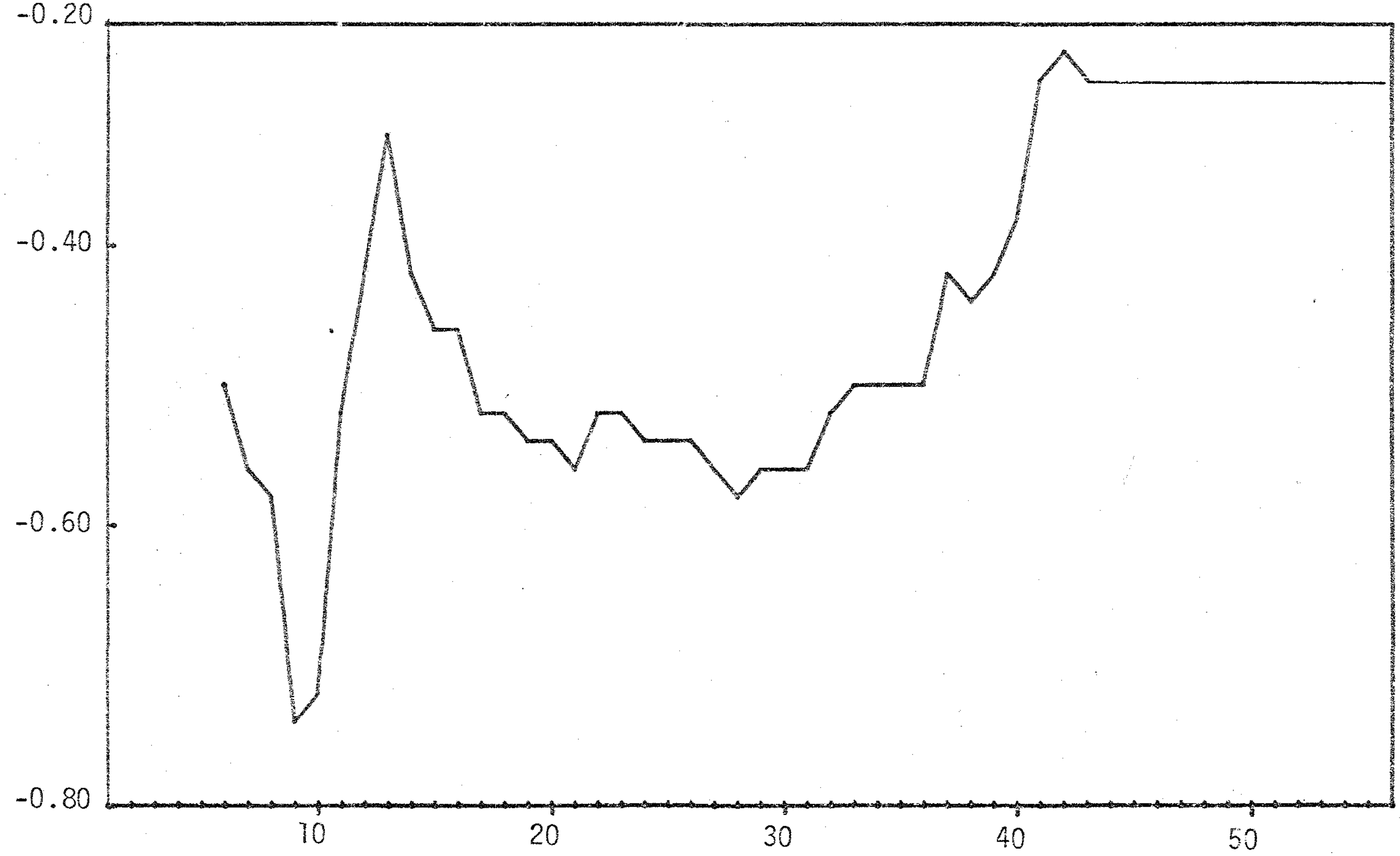


Figure 6(j)
STABILITY OF R

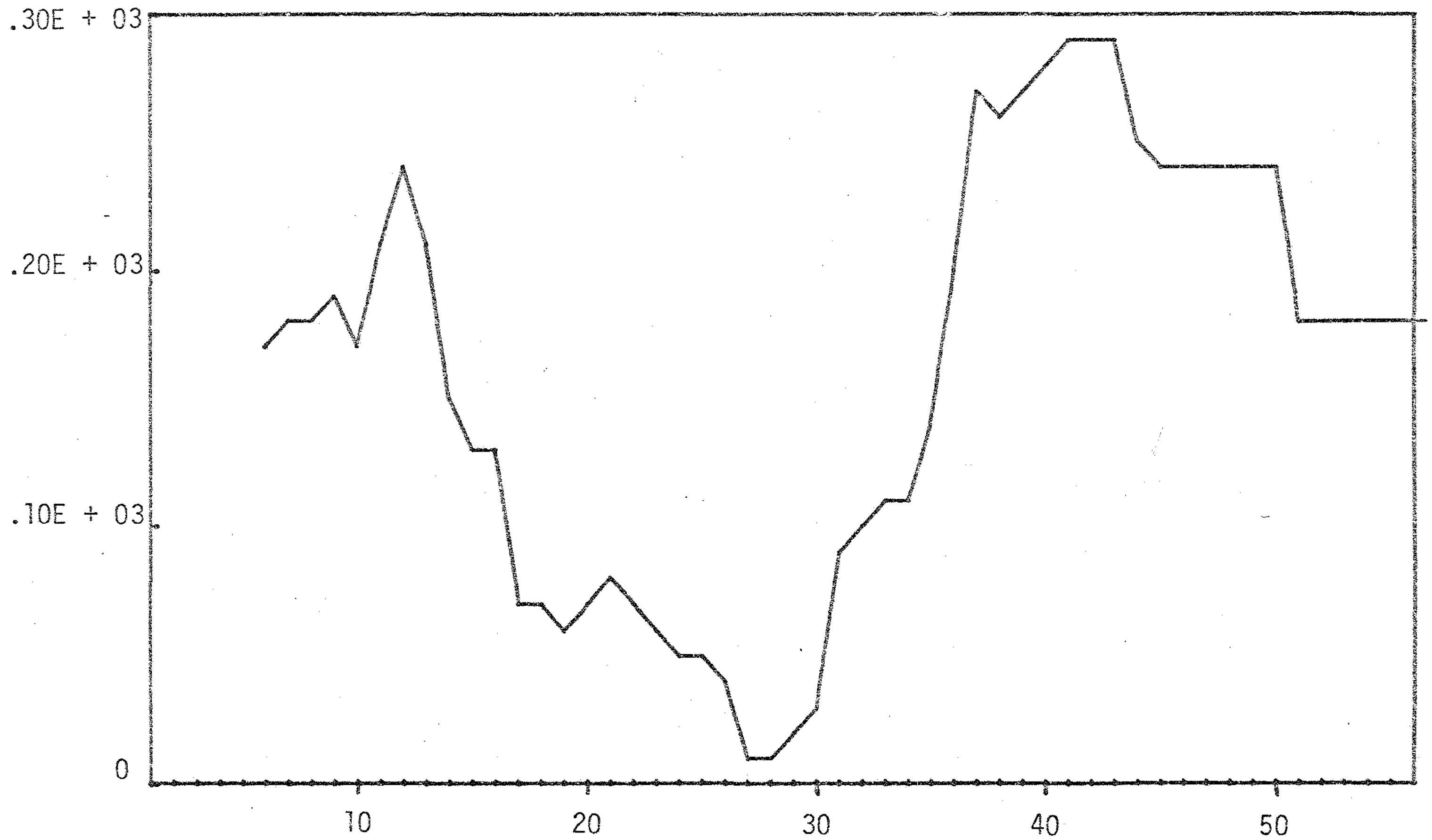


Figure 6(k)

STABILITY OF SRD IN S-EQUATION

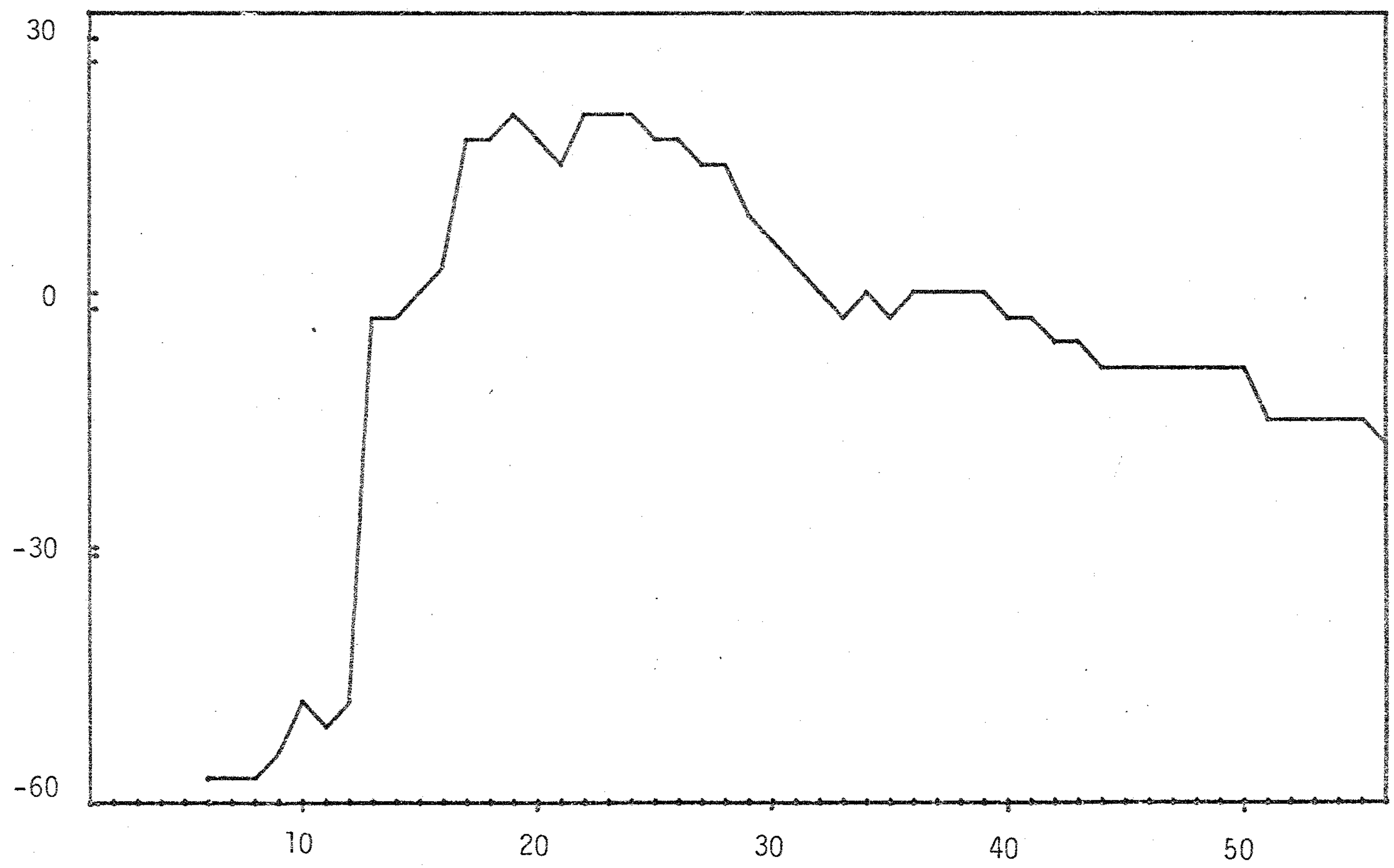
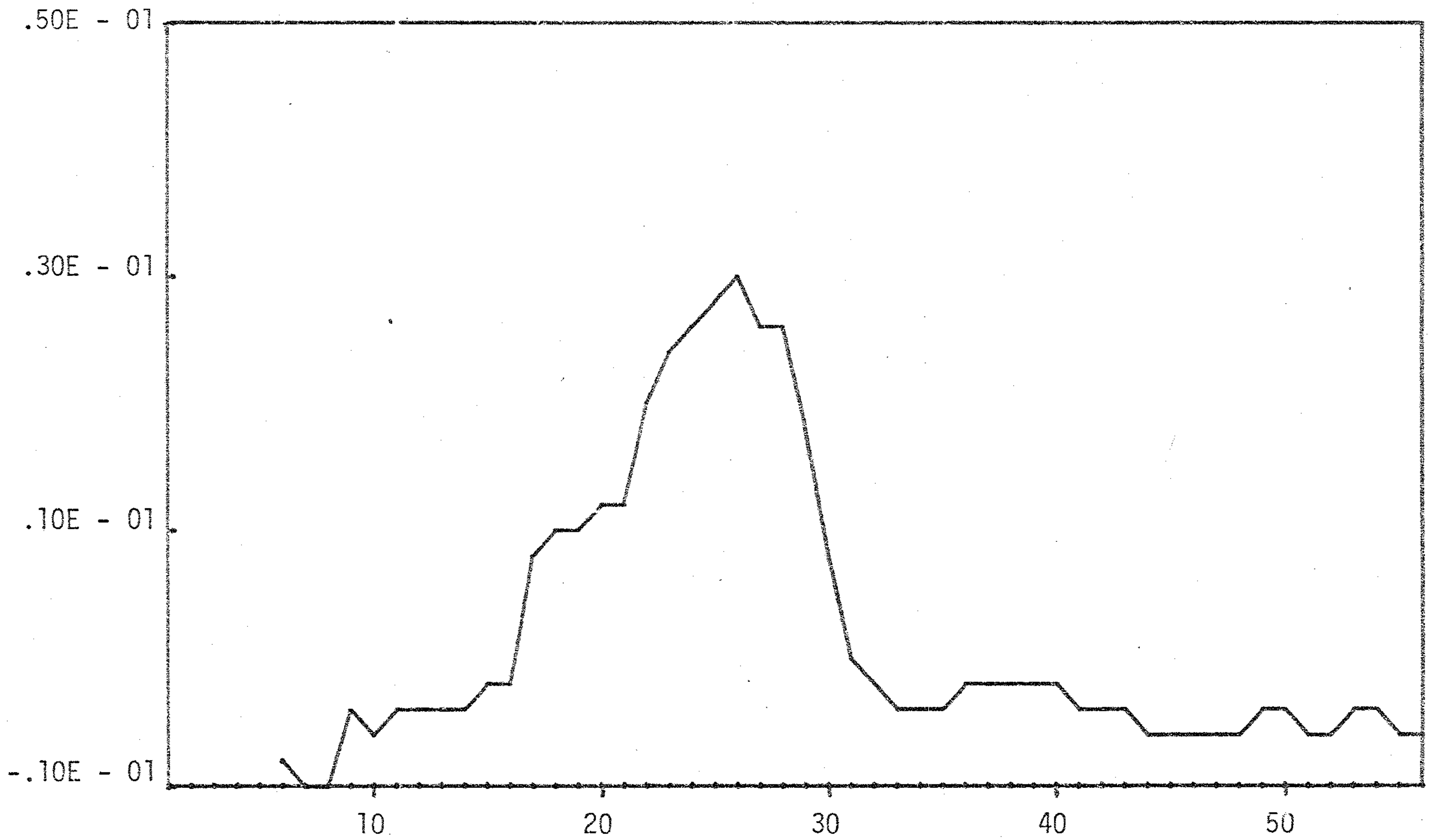


Figure 6(1)

STABILITY OF S IN SRD-EQUATION



APPENDIX 6B

TABLE OF SIGNIFICANCE VALUES FOR CUSUM OF SQUARES TEST

n	α = 0.20	α = 0.10	α = 0.05	α = 0.02	α = 0.01
1	0.40000	0.45000	0.47500	0.49000	0.49500
2	0.35044	0.44306	0.50855	0.56667	0.59596
3	0.35477	0.41811	0.46702	0.53456	0.57900
4	0.33435	0.39075	0.44641	0.50495	0.54210
5	0.31556	0.37359	0.42174	0.47692	0.51576
6	0.30244	0.35522	0.40045	0.45440	0.48983
7	0.28991	0.33905	0.38294	0.43337	0.46761
8	0.27828	0.32538	0.36697	0.41522	0.44819
9	0.26794	0.31325	0.35277	0.39922	0.43071
10	0.25884	0.30221	0.34022	0.38481	0.41517
11	0.25071	0.29227	0.32894	0.37187	0.40122
12	0.24325	0.28330	0.31869	0.36019	0.38856
13	0.23639	0.27515	0.30935	0.34954	0.37703
14	0.23010	0.26767	0.30081	0.33980	0.36649
15	0.22430	0.26077	0.29296	0.33083	0.35679
16	0.21895	0.25439	0.28570	0.32256	0.34784
17	0.21397	0.24847	0.27897	0.31489	0.33953
18	0.20933	0.24296	0.27270	0.30775	0.33181
19	0.20498	0.23781	0.26685	0.30108	0.32459
20	0.20089	0.23298	0.26137	0.29484	0.31784
21	0.19705	0.22844	0.25622	0.28898	0.31149
22	0.19343	0.22416	0.25136	0.28346	0.30552
23	0.19001	0.22012	0.24679	0.27825	0.29989
24	0.18677	0.21630	0.24245	0.27333	0.29456
25	0.18370	0.21268	0.23835	0.26866	0.28951
26	0.18077	0.20924	0.23445	0.26423	0.28472
27	0.17799	0.20596	0.23074	0.26001	0.28016
28	0.17533	0.20283	0.22721	0.25600	0.27582
29	0.17280	0.19985	0.22383	0.25217	0.27168
30	0.17037	0.19700	0.22061	0.24851	0.26772
31	0.16805	0.19427	0.21752	0.24501	0.26393
32	0.16582	0.19166	0.21457	0.24165	0.26030
33	0.16368	0.18915	0.21173	0.23843	0.25683
34	0.16162	0.18674	0.20901	0.23534	0.25348
35	0.15964	0.18442	0.20639	0.23237	0.25027
36	0.15774	0.18218	0.20387	0.22951	0.24718
37	0.15590	0.18003	0.20144	0.22676	0.24421
38	0.15413	0.17796	0.19910	0.22410	0.24134
39	0.15242	0.17595	0.19684	0.22154	0.23857
40	0.15076	0.17402	0.19465	0.21906	0.23589

Table of significance values for cusum of squares test continued

n	α = 0.20	α = 0.10	α = 0.05	α = 0.02	α = 0.01
41	0.14916	0.17215	0.19254	0.21668	0.23331
42	0.14761	0.17034	0.19050	0.21436	0.23081
43	0.14611	0.16858	0.18852	0.21212	0.22839
44	0.14466	0.16688	0.18661	0.28995	0.22605
45	0.14325	0.16524	0.18475	0.20785	0.22377
46	0.14188	0.16364	0.18295	0.20581	0.22157
47	0.14055	0.16208	0.18120	0.20383	0.21943
48	0.13926	0.16058	0.17950	0.20190	0.21735
49	0.13800	0.15911	0.17785	0.20003	0.21534
50	0.13678	0.15769	0.17624	0.19822	0.21337
51	0.13559	0.15630	0.17468	0.19645	0.21146
52	0.13443	0.15495	0.17316	0.19473	0.20961
53	0.13330	0.15363	0.17168	0.19305	0.20780
54	0.13221	0.15235	0.17024	0.19142	0.20604
55	0.13113	0.15110	0.16884	0.18983	0.20432
56	0.13009	0.14989	0.16746	0.18828	0.20265
57	0.12907	0.14870	0.16613	0.18677	0.20101
58	0.12807	0.14754	0.16482	0.18529	0.19942
59	0.12710	0.14641	0.16355	0.18385	0.19786
60	0.12615	0.14530	0.16230	0.18245	0.19635
61	0.12522	0.14422	0.16109	0.18107	0.19486
62	0.12431	0.14316	0.15990	0.17973	0.19341
63	0.12342	0.14213	0.15874	0.17841	0.19199
64	0.12255	0.14112	0.15760	0.17713	0.19061
65	0.12170	0.14013	0.15649	0.17587	0.18925
66	0.12087	0.13916	0.15540	0.17464	0.18792
67	0.12006	0.13821	0.15433	0.17344	0.18662
68	0.11926	0.13728	0.15329	0.17226	0.18535
69	0.11848	0.13637	0.15227	0.17110	0.18410
70	0.11771	0.13548	0.15127	0.16997	0.18288
71	0.11696	0.13461	0.15028	0.16886	0.18168
72	0.11622	0.13375	0.14932	0.16777	0.18051
73	0.11550	0.13291	0.14838	0.16671	0.17936
74	0.11479	0.13208	0.14745	0.16566	0.17823
75	0.11409	0.13128	0.14654	0.16463	0.17712
76	0.11341	0.13048	0.14565	0.16363	0.17604
77	0.11273	0.12970	0.14478	0.16264	0.17497
78	0.11208	0.12894	0.14392	0.16167	0.17392
79	0.11143	0.12818	0.14307	0.16071	0.17289
80	0.11079	0.12745	0.14224	0.15978	0.17188
81	0.11017	0.12672	0.14143	0.15886	0.17089
82	0.10955	0.12601	0.14063	0.15795	0.16992
83	0.10895	0.12531	0.13984	0.15706	0.16896
84	0.10835	0.12462	0.13907	0.15619	0.16802
85	0.10777	0.12394	0.13831	0.15533	0.16709

Table of significance values for cusum of squares test continued

n	α = 0.20	α = 0.10	α = 0.05	α = 0.02	α = 0.01
86	0.10719	0.12327	0.13756	0.15449	0.16618
87	0.10663	0.12262	0.13682	0.15366	0.16528
88	0.10607	0.12197	0.13610	0.15284	0.16440
89	0.10553	0.12134	0.13538	0.15203	0.16353
90	0.10499	0.12071	0.13468	0.15124	0.16268
91	0.10446	0.12010	0.13399	0.15046	0.16184
92	0.10393	0.11949	0.13331	0.14970	0.16101
93	0.10342	0.11889	0.13264	0.14894	0.16020
94	0.10291	0.11831	0.13198	0.14820	0.15940
95	0.10241	0.11773	0.13133	0.14747	0.15861
96	0.10192	0.11716	0.13070	0.14674	0.15783
97	0.10144	0.11659	0.13006	0.14603	0.15706
98	0.10096	0.11604	0.12944	0.14533	0.15631
99	0.10049	0.11550	0.12883	0.14464	0.15556
100	0.10002	0.11496	0.12823	0.14396	0.15483

CHAPTER 7: POLICY IMPLICATIONS

The major results of this thesis and their policy implications are now summarized. The general conclusion is that monetary policy is endogenous over the time period considered. There is a significant reaction of the two instruments of policy to the designated targets. This general conclusion is reinforced by a number of associated findings. The policy response of the two chosen instruments differs. It appears that the SRD instrument responds to the domestic targets; inflation and unemployment. On the other hand, the securities instrument shows a reaction to problems of external balance as part of an effective sterilization policy. The observed mutual correlation of the securities instrument with interest rates reflects the market orientation of this instrument. The interest rate is not significant in the SRD function and the same adjustment costs do not relate to the operation of this instrument. Finally, the fitted equations appear to be unstable because the policy makers revise the weights attached to the various policy targets. The SRD instrument appears to react to cyclical movements. Thus the weights on inflation and unemployment differ between the expansionary and contractionary phases of the cycle. The policy implications of the results are discussed separately.

7.1 Endogeneity and assignment of instruments

The results of the previous analysis reinforce the view that monetary policy in Australia is endogenous. Hence it should be treated as such in the formulation of econometric models. Goldfeld and

Blinder [4] have already emphasized the importance of incorporating reaction equations into econometric models. This is especially important when dynamic policy multipliers are to be derived from such models. Failure to adopt this approach will tend to bias these calculated multipliers, even though it will have no effect on the estimation of the structural coefficients of the models.

The assignment problem has its origin in the discussion by Mundell [5] who demonstrates that monetary policy should be directed towards external stabilization and fiscal policy towards internal stabilization. The findings of the analysis in Chapter 5 reveal that such an assignment of instruments exists in Australia although not along the same lines as suggested by Mundell. In fact, the findings reveal an assignment of the individual monetary policy instruments to internal and external targets. The SRD instrument, for example, displays a convincingly strong attachment to the two internal targets of policy; unemployment and inflation. On the other hand, the securities instrument is assigned to the external target; foreign reserves. Undoubtedly, this stems from the need for the Reserve Bank to control increases in foreign reserves at the stage where they have an immediate impact on the money supply via the monetary base. This 'sterilizing' or 'offsetting' process means that the effect of increased levels of foreign reserves can be neutralized by the sale of securities, thus partially compensating for the increase in the monetary base. This, in turn, partially alleviates any adverse impact on the domestic economy. The internal policy objectives, on the other hand, are found to be more effectively controlled by the SRD instrument.

7.2 Interdependence of Instruments

It is important, when analysing monetary policy reaction functions, to consider the possible interaction *between* monetary instruments. Previous reaction function studies have usually chosen only one instrument to represent the actions of the monetary authorities. In practice, however, the monetary authorities have several instruments at their disposal. Because of this fact, it is possible that the instruments may interact with one another. Hence, each instrument must be set with reference to the others. The assumption that the policy instruments are *interdependent* presupposes that they are not structurally linked. In this case, the alteration of one of the instruments has no impact on the others.

The application of such an approach to the present study results in the conclusion that there is a certain degree of 'harmonious' interaction between the SRD instrument and the securities instrument. It is found that an exogenous increase in the SRD instrument evokes a reduction in Reserve Bank holdings of Government securities - both of which involve a monetary contraction. This suggests that open market operations are used to supplement the operations of the SRD instrument. Nobay's [6] findings lend support to this argument as he finds, for Britain, that open market operations are used to reinforce calls to Special Deposits.

The findings of this present study indicate that the SRD instrument is *not* being used to reinforce an open market policy. In this case, the open market instrument does not enter the SRD equation significantly or with the correct sign. This may be explained by reference to the use of the Securities instrument as part of a 'sterilization' policy. The SRD instrument has no direct influence on the cash base and cannot be used to reinforce the Securities instrument in this role. A net sale of securities works directly on the cash base. In brief, the Securities instrument may be used to reinforce credit rationing in restricting the growth of the money supply, but the SRD instrument cannot be used to directly reinforce the Securities instrument by reducing the cash base.

7.3 Costs of adjustment

One further aspect which is related to the interdependence of the monetary policy instruments becomes clear when the relationship between the interest rate and the two monetary instruments is analysed. Firstly, the accommodating nature of the money supply is illustrated by the positive relationship between the interest rate and Reserve Bank holdings of Government Securities. That is, as the rate of interest rises, a net purchase of securities is induced, thus expanding the money supply. Such a relationship does not exist between the interest rate and the SRD instrument.

The mutual positive relationship between the interest rate and the open market instrument is observed in equation (5.8). This result has important implications for the costs associated with the adjustment of the open market instrument. It shows that an increase in the money supply brought about by a net purchase of securities has the ultimate effect of increasing market determined rates of interest in the long run. Such a result occurs as a result of the so-called 'spill-over' effect described by both Burger [1] and Friedman [2]. Equation (5.9), in which the interest rate equation is split into contractionary and expansionary periods, demonstrates further that the 'spill-over' effect works in the opposite direction as well. That is, open market sales, designed to reduce the money supply, will ultimately result in lower interest rates. Once again it is observed that no association exists between the SRD instrument and the interest rate. As a result, no political or economic costs are associated with the use of this instrument.

One of the major policy implications of these findings is that there are costs associated with the use of the open market instrument. These findings suggest that it is more appropriate to use the SRD instrument for monetary expansion and open market operations for monetary contraction. There are no political or economic costs associated with the expansion of the money supply brought about by reducing the SRD ratio. There are negative costs (in the form of long run reductions in interest rates) associated with a monetary contraction brought about by a net sale of securities. Interest rates must rise in the short run to ensure that the sale of securities takes place. This short run rise in interest rates has the effect of reducing investment and, thus, income. The resultant drop in income decreases the demand for bank credit which, in the long run, eases the pressure on interest rates as less firms compete for the available funds.

7.4 Analysis of intended contractionary and expansionary phases of policy

The use of the shift dummy approach enables the time period to be split into periods of monetary contraction and monetary expansion.

This analysis permits the weights on each target to be inferred during these differing periods. One of the most important findings revealed by this approach is the differing weight given to the unemployment target in each of the periods. The target is highly significant (in the SRD function) during periods of monetary expansion, and relatively insignificant during periods of monetary contraction. This shows the additional weight given to the unemployment target during periods of expansion. The inflation target varies little in significance between periods of monetary expansion and contraction. There is some evidence however to suggest that greater weight is given to the inflation target, compared with the unemployment target, during periods of monetary contraction. Both these findings suggest a reversal of priorities in the two phases of monetary policy: unemployment is of greater importance during a monetary expansion and inflation is given a greater weight during a monetary contraction.

A similar finding is evident from equation (5.9) where the foreign reserves target is more significant during times of monetary expansion. That is, the policy maker attaches a greater weight to this target during a monetary expansion. This occurs as the policy maker attempts to avoid an additional adverse expansionary effect on the money supply caused by an increase in foreign reserves.

The findings of the 'split-period' analysis have implications for the formulation of reaction functions. They suggest that the form of the functions change according to the phase of monetary policy being considered. This change is the result of an adjustment in the weights attached to each of the targets during each phase of policy. The changeable nature of the reaction functions is also highlighted by the findings of the stability tests.

7.5 Stability of the functions

The TIMVAR output and the cusum , cusum of squares, homogeneity and Quandt tests all suggest that the SRD- and S-functions are inherently unstable. Much of the instability is obviously due to the changing weights on the targets during different phases of monetary policy. The graphical output of the TIMVAR programme, however, allows an analysis of the particular unstable quarters. The SRD function is analysed in terms of movement in Australia's economic cycle. From this it is observed that there is a close connection between the periods of instability of the SRD equation and movements in the cycle. The instability here is due to the changing weights given to the two internal targets, unemployment and inflation. The operation of a strong counter-cyclical policy during the period of study contributes to an inherent instability in the reaction function. A similar analysis can be carried out for the S-function, this time in terms of the movements in the level of foreign reserves. The differing approaches taken here again reflect the significant assignment of the two instruments between internal and external policy. This time the connection is not as obvious or specific. However, it is possible to relate movements in the graphical cusum of squares test to movements in Australia's foreign reserves, especially during those periods when foreign reserves rose, or fell, drastically. These periods are noted as ones of extreme instability in the equation for S.

The graphical output is also important in analysing the question of interdependence between the two instruments. Equations (5.3) and (5.4) suggest the existence of a one-way 'harmonious' relationship between SRD and S, whereby changes in the SRD instrument induce changes in open market operations to complement the SRD change. The stability in this direction is noted from Figure 6(k) where there is less drastic variation over the entire time period. Figure 6(l) however, indicates a higher level of stability in the SRD equation, suggesting that the harmonious relationship does not operate in the opposite direction. That is, the SRD instrument is not used to reinforce open market policy. From 1969 onwards, the relationship is generally stable. This suggests that the two instruments have been used to complement each other more often in this period.

Among other findings, it is noted that the interest rate is only stable in the S-equation from 1971 onwards. This suggests that the monetary authorities have not always responded to changes in the interest rate by altering the supply of money via open market operations. Similarly, the unemployment, inflation and foreign reserves targets all display differing levels of stability over different time periods.

The stability analysis suggests that it is difficult to attempt an integration of the reaction functions into an econometric model without imposing significant restrictions on the period of estimation of such models. Perhaps the best approach, as Froyen [3, p. 187] emphasizes, may be to

> '... neglect monetary policy reaction functions in the model's estimation, but take account of separately estimated reaction functions when interpreting policy multipliers.'

7.6 Development of the study

Further work is required on the impact of the reaction functions on the derivation of policy multipliers. The analysis of Chapter 5 suggests that it is misleading to treat monetary policy in

Australia as exogenous. Consequently, any model of the Australian economy which attempts to observe the relative impact of monetary and fiscal policy will derive monetary multipliers which are biased. Such a model should, more correctly, take into account the presence of reaction functions for each of the monetary policy instruments. More importantly, such models should concentrate on a *disaggregated* approach to the study of monetary policy. That is, the impact of changes in the individual instruments should be analysed, in preference to a monetary aggregate such as the money stock or the monetary base.

These disaggregated functions should be inserted in a model of the Australian economy. Simulation could then be carried out over the estimation period. This would assist in the effective calculation and comparison of unbiased monetary policy multipliers with the two monetary instruments defined exogenously and endogenously.

One basic problem in this further work occurs however, as a result of the observed instability in the reaction functions. The functions themselves can only be of assistance in forecasting the direction of monetary policy as long as they exhibit an inherent stability. More work is therefore required, as well, on this basic problem of instability. Such an analysis could proceed by investigating the points at which the weights on each policy target change. That is, *desired* values for each of the targets could be formulated in an effort to detect points at which the policy makers alter the instruments in response to the changing targets.

The present study concentrates solely on current quarter reactions of the instruments and targets. Such an approach is adopted because of the interest in determining whether certain monetary instruments react, within the same quarter, to specified policy targets. Hence, the lag structure associated with such a reaction is ignored. Further work in this area should concentrate on investigating the lags attached to each policy target. This could be attempted with the use of monthly data, provided that the availability and reliability of certain data (such as, on the inflation target) permitted such an approach.

This further work should certainly be attempted in the future, especially in the light of the increasing importance of monetary policy analysis.

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